Electronic Supplementary Information for

An Environmentally Friendly Mukaiyama Aldol Reaction Catalyzed by a Strong Brønsted Acid in Solvent-Free Conditions

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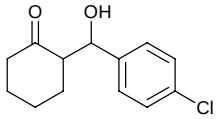
General Information

All the reactions were conducted in vials using analytical grade reagents, and were monitored by TLC, GC and GC-MS spectrometry. GC-MS spectra were recorded with an AT5973N mass selective detector connected to an AT6890N GC cross-linked methyl silicone capillary column. IR spectra were recorded using a Perkin Elmer Spectrum BX FT-IR spectrometer in neat conditions or as solutions in $CHCl_3$. ^{1}H NMR and ^{13}C NMR spectra were recorded in $CDCl_3$ with a Bruker Avance 200 spectrometer at 200 MHz and 50 MHz, respectively; chemical shifts are given in ppm relative to $CDCl_3$. TLC were performed on Fluka silica gel TLCPET foils GF 254, 2–25 μm, layer thickness 0.2 mm, medium pore diameter 60 A˚. Plates were visualized using UV light (254 nm) or treatment with an appropriate revelatory agent (*p*-anisaldehyde), followed by heating. Column flash chromatography was carried out on SiO_2 (particle size 0.032–0.063 mm/230–400 mesh). Petroleum ether refers to the fraction boiling in the range 40–60 °C and is abbreviated as PE. Commercially available reagents and solvents were purchased from Aldrich and were used without purification or distillation prior to use; Dowex 50X8 ion-exchange resin was purchased from Fluka. *o*-Benzenedisulfonimide (**1**) was prepared as described in literature.[1] Moisture-sensitive **3** was prepared following literature;[2] flasks and all equipment used for its generation were dried by electric heat gun under Ar; THF was distilled from Na/benzophenone ketyl. Acetal **13b** was prepared following a previously optimized procedure.[3] Details for the reactions and yields for the pure (GC, GC-MS, TLC, ^{1}H NMR) isolated products are listed in Table 2, 3 and 4. Structure and purity of all the products were confirmed by comparison of their physical and spectral data (IR, MS, ^{1}H NMR and ^{13}C NMR) with those reported in literature.

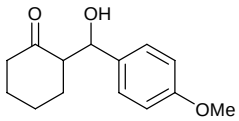
[1] M. Barbero, M. Crisma, I. Degani, R. Fochi and P. Perracino, *Synthesis*, 1998, 1171.
[2] C. Wiles, P. Watts, S. J. Haswella and E. Pombo-Villar, *Tetrahedron*, 2005, **61**, 10757.
[3] M. Barbero, S. Cadamuro, S. Dughera and P. Venturello, *Synthesis*, 2008, 1379.

General Procedures

General procedure for Mukaiyama aldol reaction:
A mixture of aldehyde **4** (2.0 mmol), trimethylsilyl enol ether **2** (0.68 g, 4.0 mmol) or **3** (0.50 g, 2.6 mmol), and *o*-benzenedisulfonimide (**1**, mol % as in Table 2) was stirred at r.t. in a vial until TLC and GC analyses showed almost complete conversion of **4**. The reaction mixture was then treated with 2 N HCl (2 mL) and vigorously stirred at rt for 5-20 min. After TLC analyses showed complete hydrolysis of **5** to **6** (or **8** to **9**), the mixture was extracted with CH_2Cl_2 (3x 10 mL). The organic extracts were washed with aqueous $NaHCO_3$ (20 mL), dried with Na_2SO_4 and concentrated under reduced pressure. The crude residue was purified by flash chromatography on a short column of silica gel (eluent is reported in footnote of Table 2). Starting from **2**, aldols **6** were revealed by treatment of the TLC plates with an appropriate revelatory agent (*p*-anisaldehyde), followed by heating. The first eluted product was the enone **7**, followed by the aldol product **6**-*syn* and then by the *anti*- diastereomer.



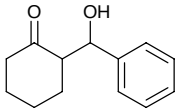
2-[(4-Chlorophenyl)(hydroxy)methyl]cyclohexan-1-one (6a).[4]
White solid, 68% yield; dr (*syn/anti*) = 50:50, determined by ^{1}H NMR analysis of title compound isolated partially as the pure *syn* and *anti* diastereomers, and partially as a mixture.
syn-**6a**:[4] ^{1}H NMR (200 MHz, $CDCl_3$): δ = 1.13–1.25 (m, 1H), 1.40–1.88 (m, 5H), 1.98–2.10 (m, 1H), 2.30–2.50 (m, 3H), 5.29 (d, *J* = 2.4 Hz, 1H), 7.12–7.28 (m, 4H); ^{13}C NMR (50 MHz, $CDCl_3$): δ = 24.7, 25.8, 27.7, 42.5, 56.8, 69.9, 127.0 (2C), 128.1 (2C), 132.1, 139.8, 214.4.
FT-IR ($CHCl_3$, cm^{-1}): 3584, 3539, 3016, 2946, 2870, 1698, 1494, 1208, 1091, 702.
anti-**6a**:[4] ^{1}H NMR (200 MHz, $CDCl_3$): δ = 1.11–1.40 (m, 1H), 1.42–1.80 (m, 5H), 1.98–2.10 (m, 1H), 2.15–2.55 (m, 3H), 4.70 (d, *J* = 8.8 Hz, 1H), 7.14–7.29 (m, 4H). ^{13}C NMR (50 MHz, $CDCl_3$): δ = 24.5, 27.5, 30.5, 42.4, 57.1, 73.8, 128.2 (2C), 128.3 (2C), 133.3, 139.4, 215.1.
FT-IR ($CHCl_3$, cm^{-1}): 3584, 3539, 3025, 2946, 2869, 1697, 1491, 1211, 1089, 781.
2-(4-Chlorobenzylidene)cyclohexan-1-one (7a).[5] Yield 5%. ^{1}H NMR (200 MHz, $CDCl_3$): δ = 1.64–1.74 (m, 2H), 1.78–1.90 (m, 2H), 2.45 (t, *J* = 6.8 Hz, 2H), 2.71 (td, *J* = 6.4 and 2.2 Hz, 2H), 7.20–7.30 (m, 4H), 7.34 (t, *J* = 2.2 Hz, 1H).
MS *m/z* (%): 220 [M$^+$](88), 129 (100).



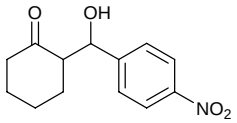
2-[(Hydroxy)(4-methoxyphenyl) methyl]cyclohexan-1-one (6b).
Solid, 68% yield; dr (*syn/anti*)= 59:41, determined by ^{1}H NMR analysis of title compound isolated partially as pure *syn* and *anti* diastereomers, and partially in mixture.
syn-**6b**:[4] ^{1}H NMR (200 MHz, $CDCl_3$): δ = 1.40–1.80 (m, 5H), 1.95–2.10 (m, 1H), 2.20–2.55 (m, 3H), 2.96 (br s, 1H), 3.74 (s, 3H), 5.26 (br s, 1H), 6.81 (d, *J* = 8.8 Hz, 2H), 7.16 (d, *J* = 8.8 Hz, 2H); ^{13}C NMR (50 MHz, $CDCl_3$): δ = 24.7, 26.0, 27.8, 42.5, 55.1, 57.1, 70.2, 113.4 (2C), 126.7 (2C), 133.4, 158.4, 214.7.

[4] Z.-H. Tzeng, H.-Y. Chen, R. J. Reddy, C.-T. Huang and K. Chen, *Tetrahedron* 2009, **65**, 2879
[5] U. P. Kreher, A. E. Rosamilia, C. L. Raston, J. L. Scott and C. R. Strauss, *Org. Lett.,* 2003, **5**, 3107

FT-IR ($CHCl_3$, cm^{-1}): 3584, 3555, 3027, 2945, 2870, 1697, 1614, 1514, 1250, 768, 668.
anti-**6b**:[4] ^1H NMR (200 MHz, $CDCl_3$): δ = 1.15–1.25 and 1.42–1.75 (m, 5H), 1.95–2.08 (m, 1H), 2.25–2.60 (m, 4H), 3.74 (s, 3H), 4.68 (d, *J* = 8.8 Hz, 1H), 6.82 (d, *J* = 8.8 Hz, 2H), 7.18 (d, *J* = 8.8 Hz, 2H); ^{13}C NMR (50 MHz, $CDCl_3$): δ = 24.5, 27.6, 30.6, 42.5, 55.1, 57.3, 74.1, 113.6 (2C), 128.0 (2C), 133.0, 159.1, 215.4.
FT-IR ($CHCl_3$, cm^{-1}): 3584, 3540, 3016, 2930, 2857, 1700, 1604, 1512, 1203, 680, 664.
2-(4-Methoxybenzylidene)cyclohexan-1-one (7b).[5] Yield 16%. ^1H NMR (200 MHz, $CDCl_3$): δ = 1.66–1.84 (m, 4H), 2.41–2.44 (m, 2H), 2.72–2.75 (m, 2H), 3.75 (s, 3H), 6.84 (d, *J* = 8.8 Hz, 2H), 7.32 (d, *J* = 8.8 Hz, 2H), 7.35–7.45 (m, 1H).
MS *m/z* (%): 216 [M^+](100).

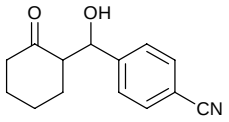


2-[(Hydroxy)(phenyl)methyl]cyclohexan-1-one (6c).
Solid, 51% yield; dr (*syn/anti*)= 57:43, determined by ^1H NMR analysis of title compound isolated partially as pure *syn* and *anti* diastereomers, and partially in mixture.
syn-**6c**:[4] ^1H NMR (200 MHz, $CDCl_3$): δ = 1.64–1.85 (m, 5H), 1.95–2.10 (m, 1H), 2.25–2.58 (m, 4H), 5.33 (d, *J* = 2.4 Hz, 1H), 7.18–7.34 (m, 5H); ^{13}C NMR (50 MHz, $CDCl_3$): δ = 24.7, 25.8, 27.8, 42.5, 57.0, 70.4, 125.6 (2C), 126.8, 128.0 (2C), 141.3, 214.7.
FT-IR ($CHCl_3$, cm^{-1}): 3684, 3584, 3027, 2946, 2870, 1698, 1605, 1522, 1451, 1208, 787, 664.
anti-**6c**:[4] ^1H NMR in mixture with *syn*-**6c** in 2:1 dr *syn*:*anti* (200 MHz, $CDCl_3$) δ = 1.40–1.83 (m, 5H), 1.98–2.10 (m, 1H), 2.23–2.62 (m, 3H), 4.73 (*anti*; d, *J* = 8.8 Hz, 1H), 5.33 (*syn*; br s, 1H), 7.18–7.34 (m, 5H).
FT-IR ($CHCl_3$, cm^{-1}): 3685, 3622, 3026, 2977, 2896, 1698, 1522, 1424, 1210, 792, 680.
2-Benzylidenecyclohexan-1-one (7c).[5] Yield 19%. ^1H NMR (200 MHz, $CDCl_3$): δ = 1.67–1.75 (m, 2H), 1.84–1.90 (m, 2H), 2.48 (t, *J* = 6.6 Hz, 2H), 2.78 (td, *J* = 6.4 and 2.2 Hz, 2H), 7.25–7.35 (m, 5H), 7.44 (t, *J* = 2.2 Hz, 1H).
MS *m/z* (%): 186 [M^+](63), 185 (100).

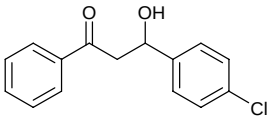


2-[(Hydroxy)(4-nitrophenyl)methyl]cyclohexan-1-one (6d).
Yellow solid, 48% yield; dr (*syn/anti*) = 50:50, determined by ^1H NMR analysis of title compound isolated partially as pure *syn* and *anti* diastereomers, and partially in mixture.
syn-**6d**:[4] ^1H NMR (200 MHz, $CDCl_3$): δ = 1.35–1.70 (m, 5H), 1.95–2.10 (m, 1H), 2.23–2.61 (m, 3H), 3.19 (d, *J* = 3.2 Hz, 1H), 5.41 (d, *J* = 2.0 Hz, 1H), 7.42 (d, *J* = 9.0 Hz, 2H), 8.12 (d, *J* = 9.0 Hz, 2H); ^{13}C NMR (50 MHz, $CDCl_3$): δ = 24.5, 25.7, 27.6, 42.4, 56.6, 69.9, 123.2 (2C), 126.4 (2C), 146.8, 149.0, 213.9.
FT-IR ($CHCl_3$, cm^{-1}): 3584, 3545, 3027, 2947, 2871, 1700, 1605, 1522, 1324, 1208, 854.
anti-**6d**:[4] ^1H NMR in mixture with *syn*-**6d** in 1:1 dr *syn*:*anti* (200 MHz, $CDCl_3$) δ = 1.15–1.83 (m, 6H), 1.95–2.10 (m, 1H), 2.15–2.40 (m, 2H), 2.40–2.60 (m, 1H), 4.83 (*anti*; d, *J* = 8.4 Hz, 1H), 5.41 (*syn*; br s, 1H), 7.35–7.50 (m, 2H), 8.07–8.20 (m, 2H).
FT-IR ($CHCl_3$, cm^{-1}): 3584, 3545, 3029, 2947, 2870, 1699, 1607, 1525, 1350, 1214, 856.

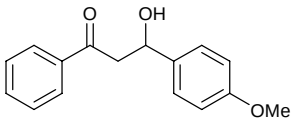
2-(4-Nitrobenzylidene)cyclohexan-1-one (7d).[6] Yield 15%. ^{1}H NMR (200 MHz, $CDCl_3$): δ = 1.60–2.00 (m, 4H), 2.51 (t, *J* = 6.6 Hz, 2H), 2.76 (td, *J* = 6.4 and 2.2 Hz, 2H), 7.35–7.39 (m, 1H), 7.45 (d, *J* = 8.8 Hz, 2H), 8.17 (d, *J* = 8.8 Hz, 2H).
MS *m/z* (%): 231 [M^+](13), 214 (100).



2-[(4-Cyanophenyl)(hydroxy)methyl]cyclohexan-1-one (6e).
Solid, yield 48%; dr (*syn/anti*) = 46:54, determined by ^{1}H NMR analysis of title compound isolated partially as pure *syn* and *anti* diastereomers, and partially in mixture.
syn-**6e**:[4] ^{1}H NMR (200 MHz, $CDCl_3$): δ = 1.38–1.80 (m, 5H), 1.95–2.10 (m, 1H), 2.20–2.40 (m, 2H), 2.45–2.58 (m, 1H), 3.21 (br s, 1H), 5.33 (d, *J* = 2.0 Hz, 1H), 7.34 (d, *J* = 9.6 Hz, 2H), 7.53 (d, *J* = 9.6 Hz, 2H); ^{13}C NMR (50 MHz, $CDCl_3$): δ = 24.6, 25.7, 27.6, 42.4, 56.6, 70.0, 109.8, 126.3 (2C), 130.4, 132.0 (2C), 146.9, 213.9.
FT-IR ($CHCl_3$, cm^{-1}): 3584, 3545, 3024, 2947, 2871, 2232, 1701, 1604.
anti-**6e**:[4] ^{1}H NMR in mixture with *syn*-**6d** in 0.8:1 dr *syn*:*anti* (200 MHz, $CDCl_3$) δ = 1.15–1.83 (m, 6H), 1.95–2.05 (m, 1H), 2.15–2.40 (m, 3H), 4.77 (*anti*; d, *J* = 8.4 Hz, 1H), 5.36 (*syn*; br s, 1H), 7.30–7.42 (m, 2H), 7.50–7.61 (m, 2H).
FT-IR ($CHCl_3$, cm^{-1}): 3584, 3545, 3020, 2931, 2857, 2232, 1682, 1604.
2-(4-Cyanobenzylidene)cyclohexan-1-one (7e).[7] Yield 14%. ^{1}H NMR (200 MHz, $CDCl_3$): δ = 1.69–1.80 (m, 2H), 1.83–1.95 (m, 2H), 2.50 (t, *J* = 6.8 Hz, 2H), 2.70–2.88 (m, 2H), 7.39 (d, *J* = 8.4 Hz, 2H), 7.48 (s, 1H), 7.60 (d, *J* = 8.2 Hz, 2H).
MS *m/z* (%): 211 [M^+](100).

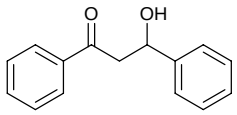


3-(4-Chlorophenyl)-3-hydroxy-1-phenylpropan-1-one (9a).[8]
White needles, mp 99.4–100.4 °C (CH_2Cl_2–PE) [lit.[9] 96–96.5 °C]. Yield 87%.
^{1}H NMR (200 MHz, $CDCl_3$): δ = 3.20 (br s, 1H), 3.28 (d, *J* = 6.0 Hz, 2H), 5.20–5.31 (m, 1H), 7.26–7.32 (m, 4H), 7.35–7.45 (m, 2H), 7.48–7.55 (m, 1H), 7.80–7.93 (m, 2H). ^{13}C NMR (50 MHz, $CDCl_3$): δ = 47.1, 69.2, 127.0 (2C), 128.0 (2C), 128.5 (2C), 128.6 (2C), 133.1, 133.6, 136.2, 141.3, 199.8.
FT-IR ($CHCl_3$, cm^{-1}): 3584, 3550, 3010, 2905, 1677, 1598, 1582, 1494, 1450, 1093, 1014, 800, 668.

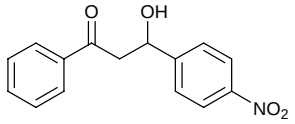


[6] U. Das, A. Doroudi, S. Das, B. Bandy, J. Balzarini, E. De Clercq and J. R. Dimmock, *Bioorg. Med. Chem.*, 2008, **16**, 6261.
[7] E. D. Beaulieu, L. Voss and D. Trauner, *Org. Lett.*, 2008, **10**, 869.
[8] C. H. Cheon and H. Yamamoto, *Tetrahedron*, 2010, **66**, 4257.
[9] E. Hasegawa, K. Ishiyama, T. Horaguchi and T. Shimizu, *J. Org. Chem*., 1991, **56**, 1631.

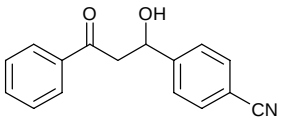
3-Hydroxy-3-(4-methoxyphenyl)-1-phenylpropan-1-one (9b).[8,10]
Colorless oil; yield 88%.
^{1}H NMR (200 MHz, $CDCl_3$): δ = 3.24–3.32 (m, 2H), 3.50 (br s, 1H), 3.72 (s, 3H), 5.22 (m, 1H), 6.80–6.90 (m, 2H), 7.25–7.60 (m, 5H), 7.84–7.92 (m, 2H); ^{13}C NMR (50 MHz, $CDCl_3$): δ = 47.2, 55.1, 69.5, 113.7 (2C), 126.9 (2C), 128.0 (2C), 128.5 (2C), 133.4, 135.1, 136.5, 158.9, 199.9.
FT-IR (neat, cm^{-1}): 3480, 3062, 3003, 2907, 2837, 1682, 1513, 1449, 1249, 1034, 833, 724, 691.
MS *m/z* (%): 252 [M^+] (5), 238 [M^+–18] (100).



3-Hydroxy-1,3-diphenylpropan-1-one (9c).[8,10]
Viscous colorless oil; yield 80%.
^{1}H NMR (200 MHz, $CDCl_3$): δ = 2.46 (br s, 1H), 3.32 (d, *J* = 6.2 Hz, 2H), 5.30 (m, 1H), 7.20–7.45 (m, 7H), 7.50–7.56 (m, 1H), 7.80–7.95 (m, 2H); ^{13}C NMR (50 MHz, $CDCl_3$): δ = 47.3, 69.9, 125.6, 127.5, 128.0, 128.4, 128.5, 133.5, 136.4, 142.8, 200.0.
FT-IR ($CDCl_3$, cm^{-1}): 3584, 3545, 3035, 3011, 2905, 1677, 1599, 1582, 1496, 1450, 778, 691, 668.



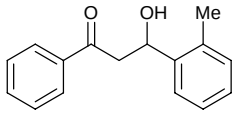
3-Hydroxy-3-(4-nitrophenyl)-1-phenylpropan-1-one (9d).[8,10]
White needles, mp 114.0–114.7 °C (CH_2Cl_2–PE) [lit.[10] 113–114 °C]. Yield 91%.
^{1}H NMR (200 MHz, $CDCl_3$): δ = 3.26–3.36 (m, 2H), 3.82 (br s, 1H), 5.35–5.44 (m, 1H), 7.35–7.48 (m, 2H), 7.50–7.60 (m, 3H), 7.85–7.92 (m, 2H), 8.14–8.20 (m, 2H); ^{13}C NMR (50 MHz, $CDCl_3$): δ = 46.8, 69.0, 123.6 (2C), 126.4 (2C), 128.0 (2C), 128.7 (2C), 133.9, 135.9, 147.1, 150.0, 199.3.
FT-IR ($CDCl_3$, cm^{-1}): 3584, 3550, 2907, 3024, 1677, 1600, 1582, 1524, 1450, 1350, 1208, 736, 670.



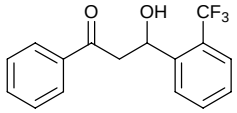
3-(4-Cyanophenyl)-3-hydroxy-1-phenylpropan-1-one (9e).[11]
White needles, mp 86.0–87.0 °C (CH_2Cl_2–PE). Yield 96%.
^{1}H NMR (200 MHz, $CDCl_3$): δ = 3.20–3.32 (m, 2H), 3.75 (br s, 1H), 5.25–5.38 (m, 1H), 7.30–7.60 (m, 7H), 7.80–7.90 (m, 2H); ^{13}C NMR (50 MHz, $CDCl_3$): δ = 46.9, 69.1, 111.1, 118.6, 126.3 (2C), 128.0 (2C), 128.6 (2C), 132.5 (2C), 133.8, 136.0, 148.3, 199.3.
FT-IR ($CDCl_3$, cm^{-1}): 3584, 3550, 3030, 2906, 2233, 1678, 1598, 1581, 1450, 1231, 1210, 798, 727.

[10] C. W. Downey and M. W. Johnson, *Tetrahedron Lett.*, 2007, **48**, 3559.

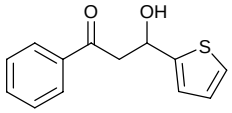
[11] H. Terao, Y. Ono, Y. Ito, M. Isogai, T. Hamada, Y. Imanishi and A. Tsumoda, JP03188425 A19910816; *Chem Abstr*. 1991, **116**, 162143.



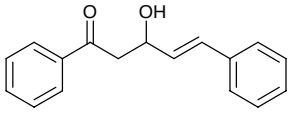
3-Hydroxy-1-phenyl-3-(2-tolyl)propan-1-one (9f).[8]
Colorless oil; yield 98%.
^{1}H NMR (200 MHz, $CDCl_3$): δ = 2.31 (s, 3H), 3.24-3.30 (m, 2H), 3.57 (br s, 1H), 5.50-5.58 (m, 1H), 7.12–7.24 (m, 3H), 7.35–7.60 (m, 4H), 7.88–7.98 (m, 2H); ^{13}C NMR (50 MHz, $CDCl_3$): δ = 19.0, 46.0, 66.3, 125.4, 126.3, 127.3, 128.0 (2C), 128.6 (2C), 130.3, 133.5, 133.9, 136.4, 140.9, 200.1
FT-IR (neat, cm^{-1}): 3469, 3063, 2923, 1682, 1598, 1580, 1490, 1450, 1212, 1065, 760, 691.



3-Hydroxy-1-phenyl-3-(2-trifluoromethylphenyl)propan-1-one (9g).
Colorless oil; yield 80%.
^{1}H NMR (200 MHz, $CDCl_3$): δ = 3.10-3.40 (m, 2H), 2.89 (br s, 1H), 5.70-5.78 (m, 1H), 7.30–7.65 (m, 6H), 7.84–7.95 (m, 3H); ^{13}C NMR (50 MHz, $CDCl_3$): δ = 47.3, 65.4, 125.3 (q, *J* = 6.6 Hz), 126.2 (q, *J* = 30.0 Hz), 127.5, 127.7, 128.0 (2C), 128.5 (2C), 129.5 (q, *J* = 265 Hz), 132.3, 133.6, 136.1, 141.8, 199.5.
FT- MS *m/z* (%): 294 [M^+] (5), 276 [M^+–18] (20), 105 (100).
IR (neat, cm^{-1}): 3480, 3069, 2915, 1682, 1598, 1582, 1493, 1451, 1308, 1166, 1060, 1037, 771.



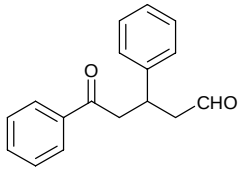
3-Hydroxy-1-phenyl-3-(2-thienyl)propan-1-one (9h).[8,10]
Viscous oil, yield 89%.
^{1}H NMR (200 MHz, $CDCl_3$): δ = 3.35-3.46 (m, 2H), 3.93–3.99 (m, 1H), 5.45-5.55 (m, 1H), 6.88–6.98 (m, 2H), 7.15–7.20 (m, 1H), 7.35–7.55 (m, 3H), 7.83–7.91 (m, 2H); ^{13}C NMR (50 MHz, CDCl3): δ = 47.1, 66.2, 123.5, 124.5, 126.6, 128.1, 128.6, 133.6, 136.3, 146.8, 199.3.
FT-IR (neat, cm^{-1}): 3468, 3067, 2904, 1678, 1597, 1580, 1449, 1212, 1040, 759, 693.



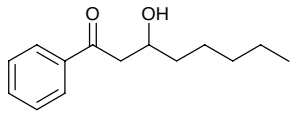
(*E*)-3-Hydroxy-1,5-diphenylpent-4-en-1-one (9i).[8,10]
White solid, mp 53.2–54.1 °C (CH_2Cl_2/PE) [lit.[12] 52.1-52.9 °C]; yield 80%.
^{1}H NMR (200 MHz, $CDCl_3$): δ = 3.23 (d, *J* = 6.0 Hz, 2H), 3.49 (br s, 1H), 4.85–4.93 (m, 1H), 6.27 (dd, *J* = 15.8 and 6 Hz, 1H), 6.66 (d, *J* = 16.0 Hz, 1H), 7.20–7.55 (m, 8H), 7.90–7.95 (m, 2H); ^{13}C

[12] L. Tao, C. Lin, H. Taiping, *Pestic. Biochem. Physiol.*, 2007, **89**, 60.

NMR (50 MHz, $CDCl_3$): δ = 45.1, 68.5, 126.4, 127.5, 128.0, 128.4, 128.5, 130.2, 130.3, 133.5, 136.4, 136.5, 199.8.
FT-IR ($CHCl_3$, cm^{-1}): 3584, 3545, 3011, 2904, 1678, 1599, 1585, 1450, 1215, 704.



5-Oxo-3,5-diphenylpentanal (10).[13,14]
Colorless oil; yield 16%.
^{1}H NMR (200 MHz, $CDCl_3$): δ = 2.77–2.84 (m, 2H), 3.27–3.32 (m, 2H), 3.84–3.98 (m, 1H), 7.20–7.50 (m, 8H), 7.82–7.90 (m, 2H), 9.65 (s, 1H); ^{13}C NMR (50 MHz, $CDCl_3$): δ = 35.2, 44.8, 49.4, 126.8, 127.2, 127.9, 128.5, 128.7, 133.1, 136.6, 143.0, 197.9, 201.0.
FT-IR ($CHCl_3$, cm^{-1}): 3584, 3535, 3035, 2965, 2940, 1722, 1678, 1599, 1582, 1450, 1273, 690.
MS *m/z* (%): 252 [M^+] (5), 105 (100).



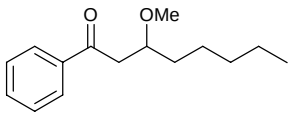
3-Hydroxy-1-phenyloctan-1-one (12).[15]
Viscous colorless oil; yield 32%.
^{1}H NMR (200 MHz, $CDCl_3$): δ = 0.77–0.90 (m, 3H), 1.18–1.60 (m, 8H), 2.89–2.20 (m, two dd overlapped and one br s, 3H), 4.11–4.20 (m, 1H), 7.34–7.55 (m, 3H), 7.82–7.95 (m, 2H); ^{13}C NMR (50 MHz, $CDCl_3$): δ = 13.9, 22.5, 25.1, 31.6, 36.3, 44.8, 67.6,127.9, 128.5, 133.3, 136.6, 200.9.
FT-IR ($CHCl_3$, cm^{-1}): 3584, 3545, 3009, 2905, 2861, 1677, 1599, 1582, 1450, 1234, 1214, 1181.
MS *m/z* (%): 220 [M^+] (5), 206 [M^+–18] (25), 105 (100).

Synthesis of cyclohexanecarbaldehyde dimethyl acetal (13b):
Title compound was prepared following a previously optimized procedure.[3]
To a solution of cyclohexanecarbaldehyde (1.12 g, 10 mmol) in methanol (10 mL) was added *o*-benzenedisulfonimide (**1**; 0.5 mol%; 0.011 g, 0.05 mmol) and the reaction mixture was stirred at r.t. for 1h. The reaction mixture was treated with pentane and $NaHCO_3$, extracted with pentane (3 x 10 mL) and evaporated under reduced pressure. The residue was virtually pure (GC, GC–MS, TLC, ^{1}H NMR and ^{13}C NMR) title compound in 99 % yield (1.56 g); colorless oil.[16] Traces of a trimer of cyclohexane carbaldehyde were detected; GC-MS: 335 ([M^+-1] 5), 225 (70), 113 (85), 95 (100).
^{1}H NMR (200 MHz, $CDCl_3$): δ = 1.48–1.72 (m, 6H), 0.80–1.20 (m, 5H), 3.25 (s, 6H), 3.91 (d, *J* = 7.2 Hz, 1H); ^{13}C NMR (50 MHz, $CDCl_3$): δ = 25.6, 26.2, 27.8, 39.8, 53.3, 108.3.
MS *m/z* (%): 157 [M^+-1](5), 75 (100).

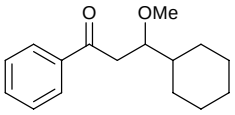
General procedure for Mukaiyama aldol-type reaction:

[13] J. Bielowski, S. Brandänge, L. Lindblom and S. Ramanvongse, *Acta Chem. Scand., Ser. B,* 1979, **33**, 462.
[14] W. Wang, H. Li and J. Wang, *Org. Lett*., 2005, **7**, 1637.
[15] T.-P. Loh and X.-R. Li, *Tetrahedron*, 1999, **55**, 10789.
[16] Y. Mei, P. A. Bentley and J. Du, *Tetrahedron Lett.*, 2009, **50**, 4199.

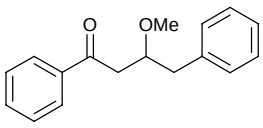
A mixture of aldehyde dimethyl acetal **13** (2.0 mmol), trimethylsilyl enol ether **3** (0.50 g, 2.6 mmol), and *o*-benzenedisulfonimide (**1**, mol % as in Table 3) was stirred at r.t. in a vial until TLC and GC analyses showed almost complete conversion of **13**. The mixture was extracted with CH_2Cl_2, washed with water and then extracted with CH_2Cl_2 (3 x 10 mL). The organic extracts were dried with Na_2SO_4 and concentrated under reduced pressure. The crude residue was purified by flash chromatography on a short column of silica gel (eluent reported in footnote of Table 3).



3-Methoxy-1-phenyloctan-1-one (14a).
Colorless oil; yield 81%.
^{1}H NMR (200 MHz, $CDCl_3$): δ = 0.70–0.85 (m, 3H), 1.20–1. 05 (m, 6H), 1.45–1.60 (m, 2H), 2.86 (dd, *J* = 16.2 and 5.4 Hz, 1H), 2.86 (overlapped dd, *J* = 16.0 and 6.8 Hz, 1H), 3.26 (s, 3H), 3.75–3.85 (m, 1H), 7.35–7.50 (m, 3H), 7.85–7.93 (m, 2H); ^{13}C NMR (50 MHz, $CDCl_3$): δ = 13.9 22.4, 24.7, 31.7, 34.2, 43.1, 57.0, **77.7,** 128.0 (2C), 128.4 (2C), 132.8, 137.2, 198.9.
FT-IR (neat, cm^{-1}): 3062, 2930, 2860, 1686, 1598, 1581, 1449, 1364, 1282, 1212, 1097, 753, 659.
MS *m/z* (%): 234 [M^+] (2), 219 [M^+-15] (10), 105 (100).



3-Cyclohexyl-3-methoxy-1-phenylpropan-1-one (14b).[10]
Colorless oil, 61% yield.
^{1}H NMR (200 MHz, $CDCl_3$): δ = 0.90–1.18 (m, 5H), 1.45–1.72 (m, 6H), 2.84 (dd, *J* = 16.2 and 4.0 Hz, 1H), 3.13 (overlapped dd, *J* = 16.2 and 7.8 Hz, 1H), 3.23 (s, 3H), 3.59–3.68 (m, 1H), 7.32–7.46 (m, 3H), 7.85–7.92 (m, 2H); ^{13}C NMR (50 MHz, $CDCl_3$): δ = 26.1 (2C), 26.4, 28.3, 28.4, 40.6, 41.7, 58.1, 81.6, 128.0 (2C), 128.3 (2C), 132.7, 137.3, 199.2.
FT-IR ($CHCl_3$, cm^{-1}): 3013, 2905, 2856, 1684, 1598, 1582, 1450, 1232, 1095.
MS *m/z* (%): 246 [M^+] (2), 231 [M^+-15] (10), 105 (100).



3-Methoxy-1,4-diphenylbutan-1-one (14c).[17]
Colorless viscous oil; yield 33%.
^{1}H NMR (200 MHz, $CDCl_3$): δ = 2.80–2.91 (m, 3H), 3.18 (dd, *J* = 16.4 and 7.2 Hz, 1H), 3.28 (s, 3H), 4.05–4.11 (m, 1H), 7.15–7.25 (m, 5H), 7.39–7.50 (m, 3H), 7.83 (d, *J* = 7.8 Hz, 2H); ^{13}C NMR (50 MHz, $CDCl_3$): δ = 40.0, 42.6, 57.4, 78.4, 124.3, 128.0 (2C), 128.4 (2C), 128.7 (2C), 129.4 (2C), 132.9, 137.0, 138.0, 198.6.
FT-IR (neat, cm^{-1}): 3063, 3029, 2932, 2830, 1683, 1599, 1582, 1496, 1450, 1360, 1266, 1121, 760, 691.

[17] J. Moorthy, S. Samanta, A. L. Koner, S. Saha and W. M. Nau, *J. Am. Chem. Soc.,* 2008, **130**, 13608.

MS *m/z* (%): 239 [M^+-15] (2), 105 (100).

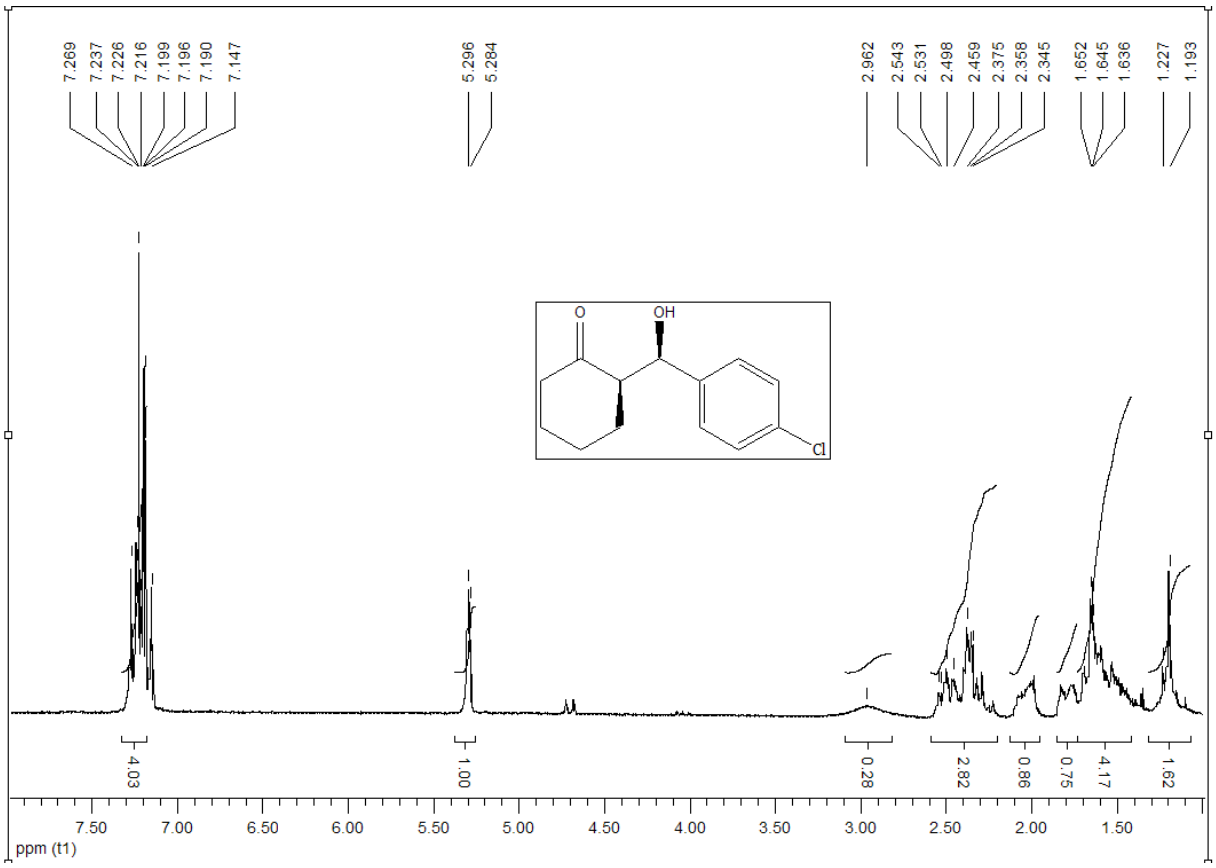
Mechanistic studies:

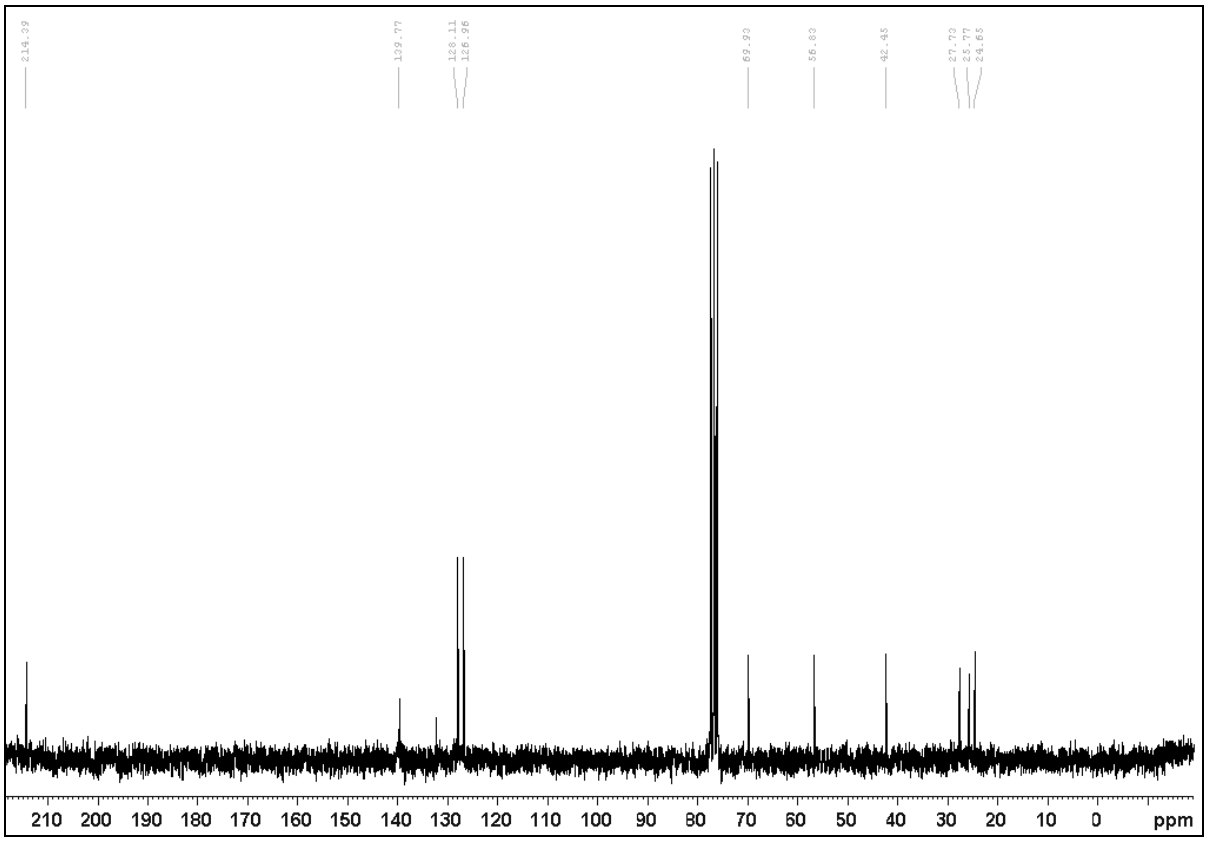
A) Mukaiyama aldol reaction in the presence of a hindered base:[18,19]
A mixture of trimethylsilyl enol ether **3** (0.50 g, 2.6 mmol), 2,6-di(*t*-butyl)-4-methylpyridine (5 mol %, 0.0205 g) and *o*-benzenedisulfonimide (**1**, 2 mol %, 0.0088 g) was stirred at r.t. in a vial; after 5 min aldehyde **4f** (0.24 g; 2.0 mmol) was added. The reaction was suspended after 24 h. Acid hydrolysis and usual work-up followed by flash chromatography gave **9f** (0.40 g; 83%; entry 1 of Table 4).

B) Mukaiyama aldol reaction catalyzed by *in situ* formed Lewis catalyst:[18,19]
Reactions were carried out on 2 mmol of reactants, as usual.
A mixture of trimethylsilyl enol ether **2** or **3** (2 mol %) and one equivalent of **1** was stirred at r.t. in a vial: ^{1}H NMR spectra showed the formation of *N*-trimethylsilyl-*o*-benzenedisulfonimide and TLC analysis showed complete disappearance of the silyl enol ether. Then reactants **2** and **4b** (or **3** and **4f**) were added and the reactions were run as in the general procedure. Both reactions proceeded in a similar fashion. In both cases, hydrolysis of **2** (or **3**) was faster than the expected Mukaiyama reaction. The reactions reached completion in reduced times and yields with respect to the optimized procedures, as reported in entries 2 and 3 of Table 4.

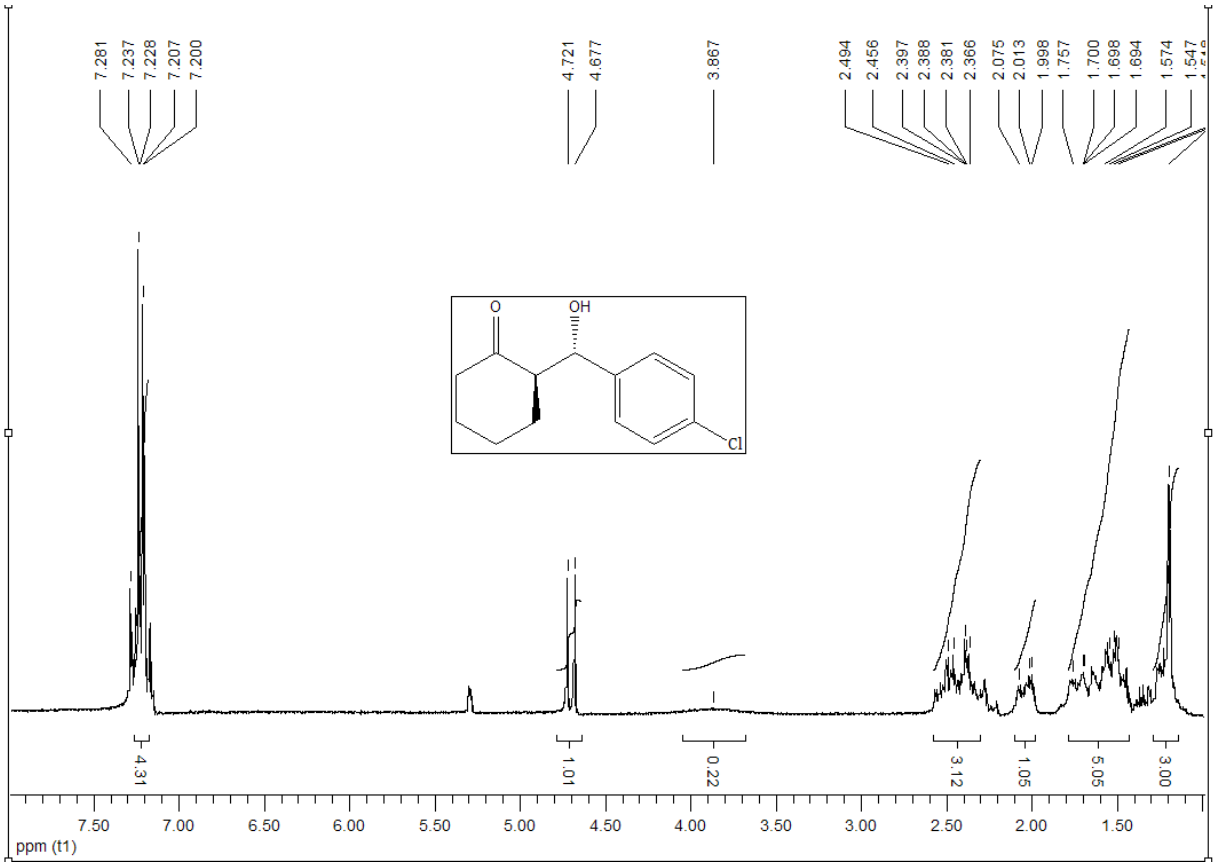
[18] P. García-García, F. Lay, P. García-García, C. Rabalakos and B. List, *Angew. Chem. Int. Ed*., 2009, **48**, 4363.
[19] C. H. Cheon and H. Yamamoto, *Tetrahedron Lett*., 2009, **50**, 3555.

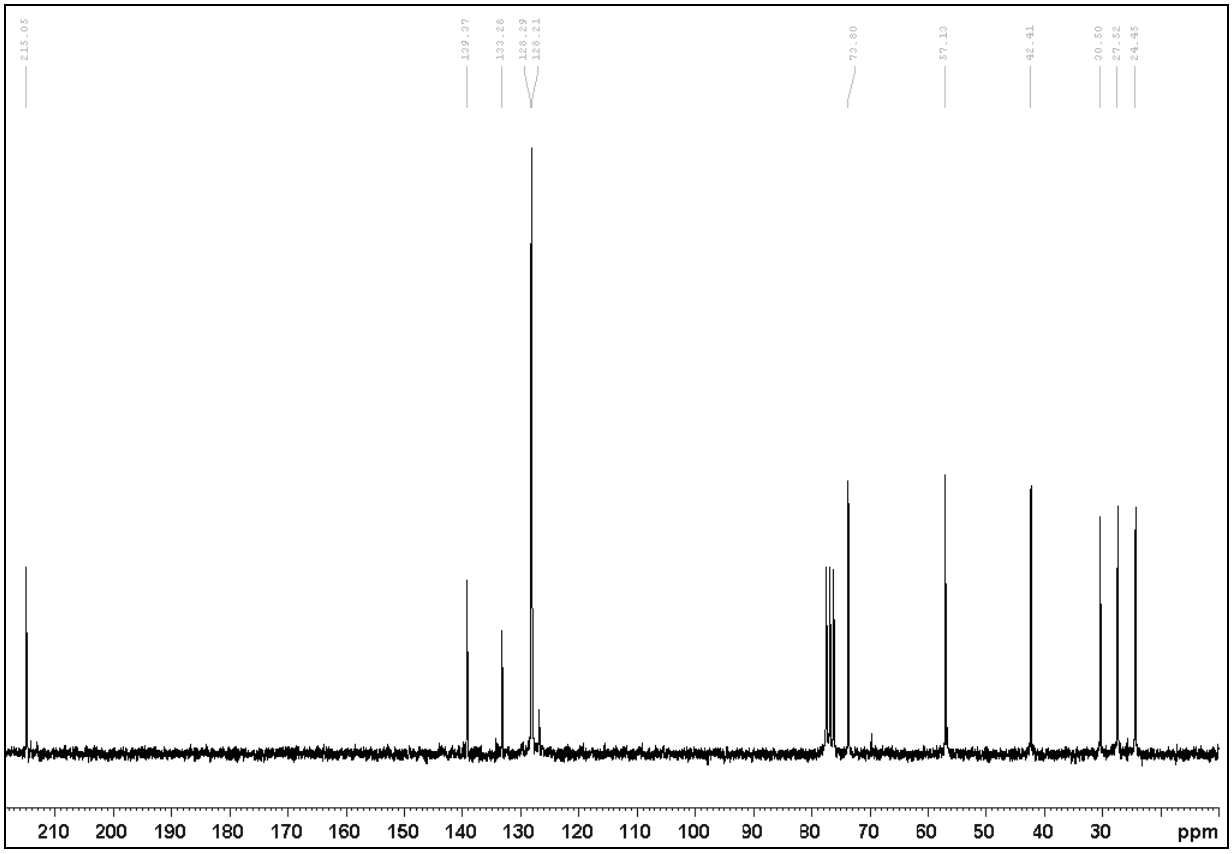
(*syn*)-2-[(4-Chlorophenyl)(hydroxy)methyl]cyclohexan-1-one (6a).



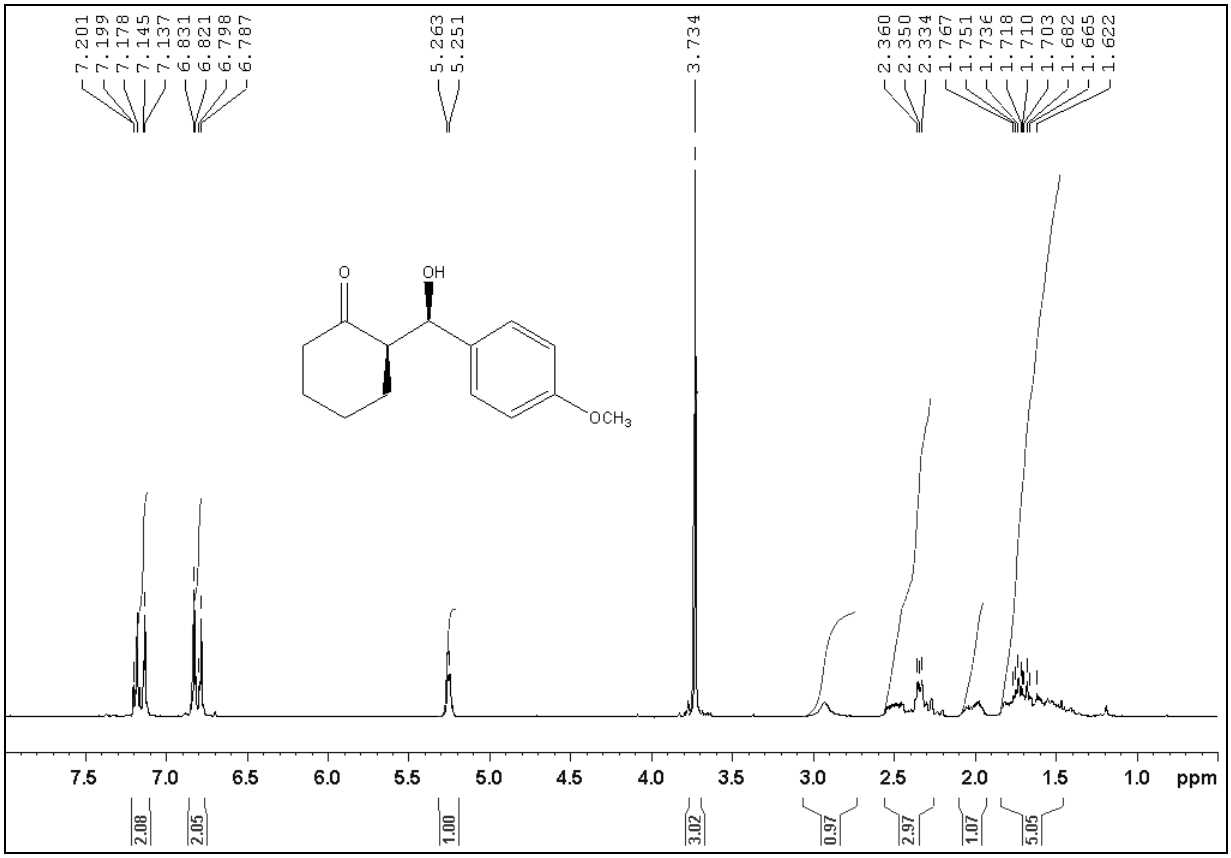


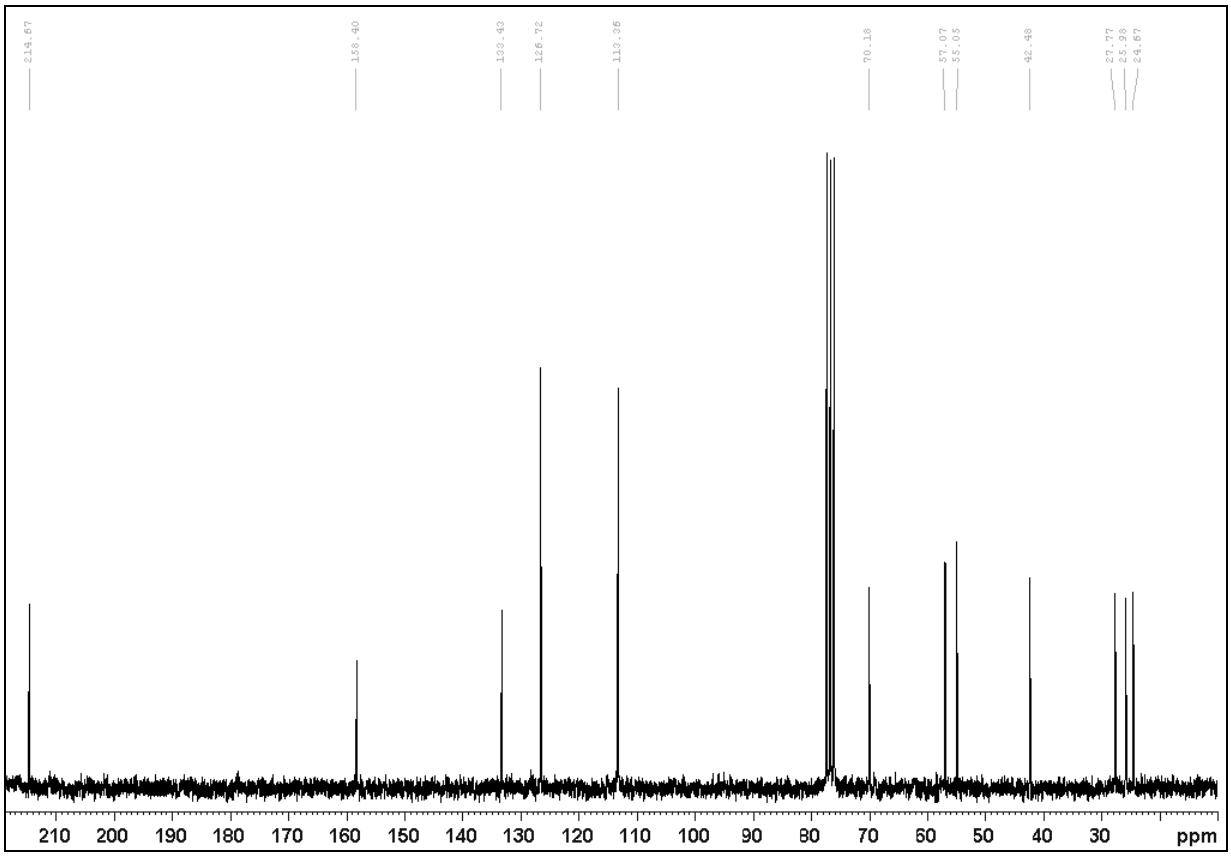
(*anti*)-2-[(4-Chlorophenyl)(hydroxy)methyl]cyclohexan-1-one (6a).



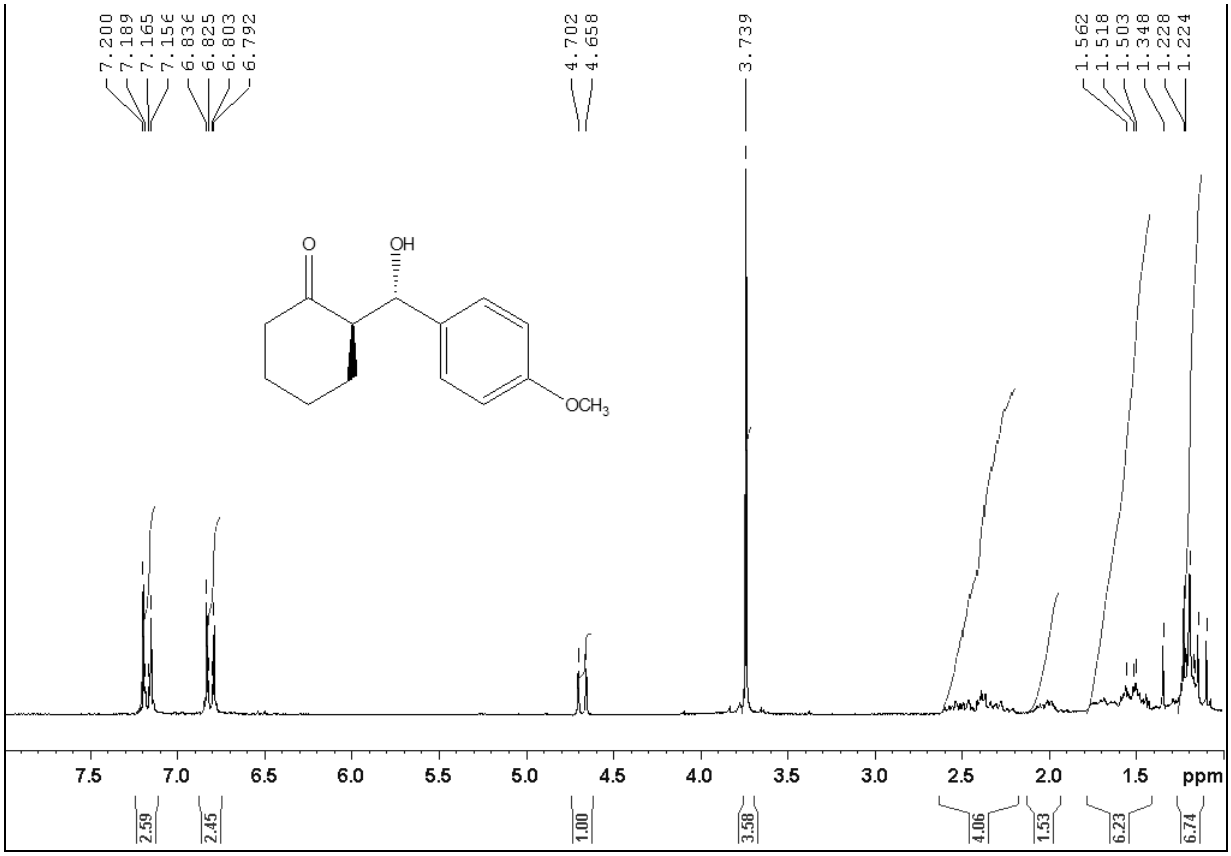


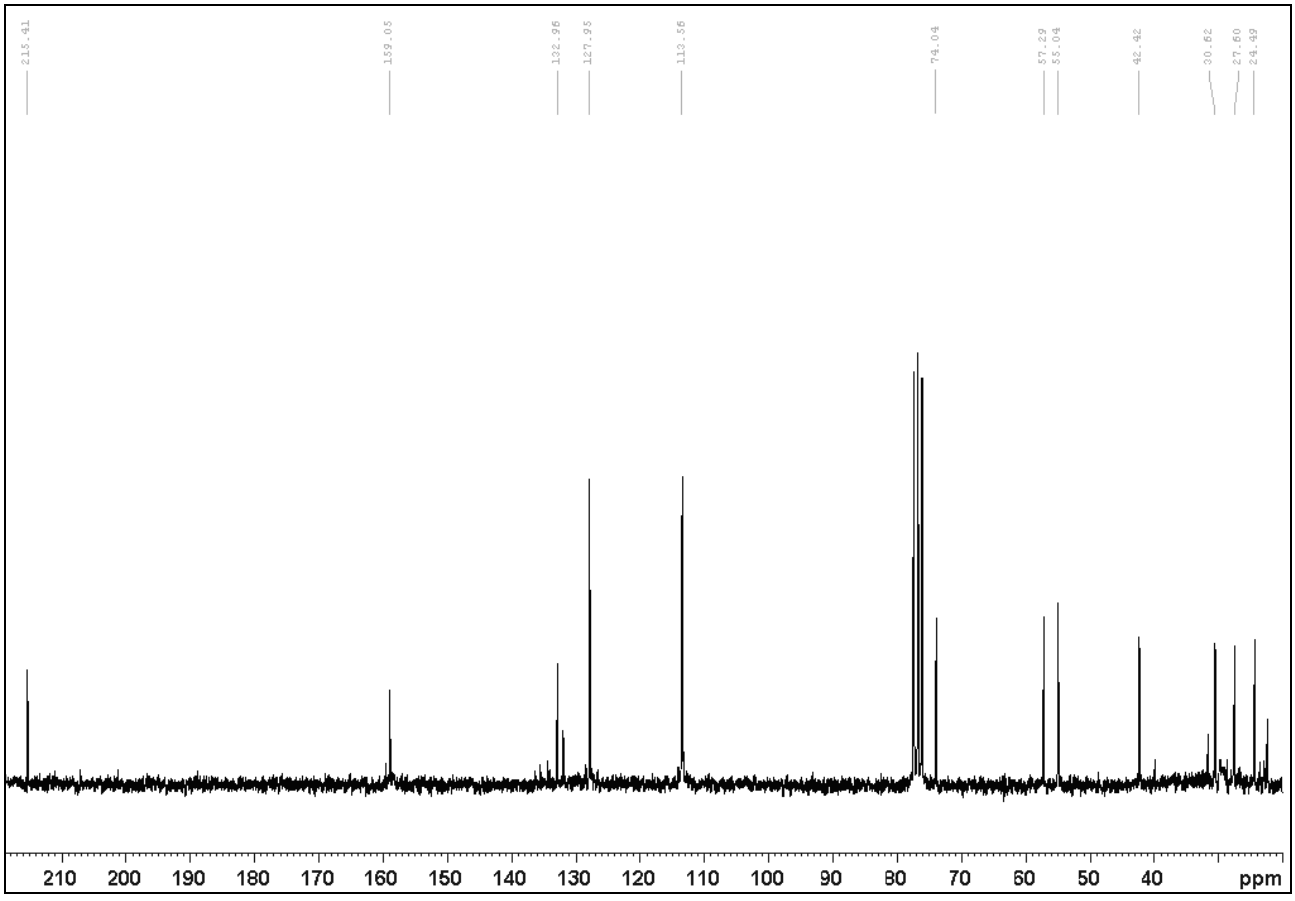
(*syn*)-2-[(4-Methoxyphenyl)(hydroxy)methyl]cyclohexan-1-one (6b).



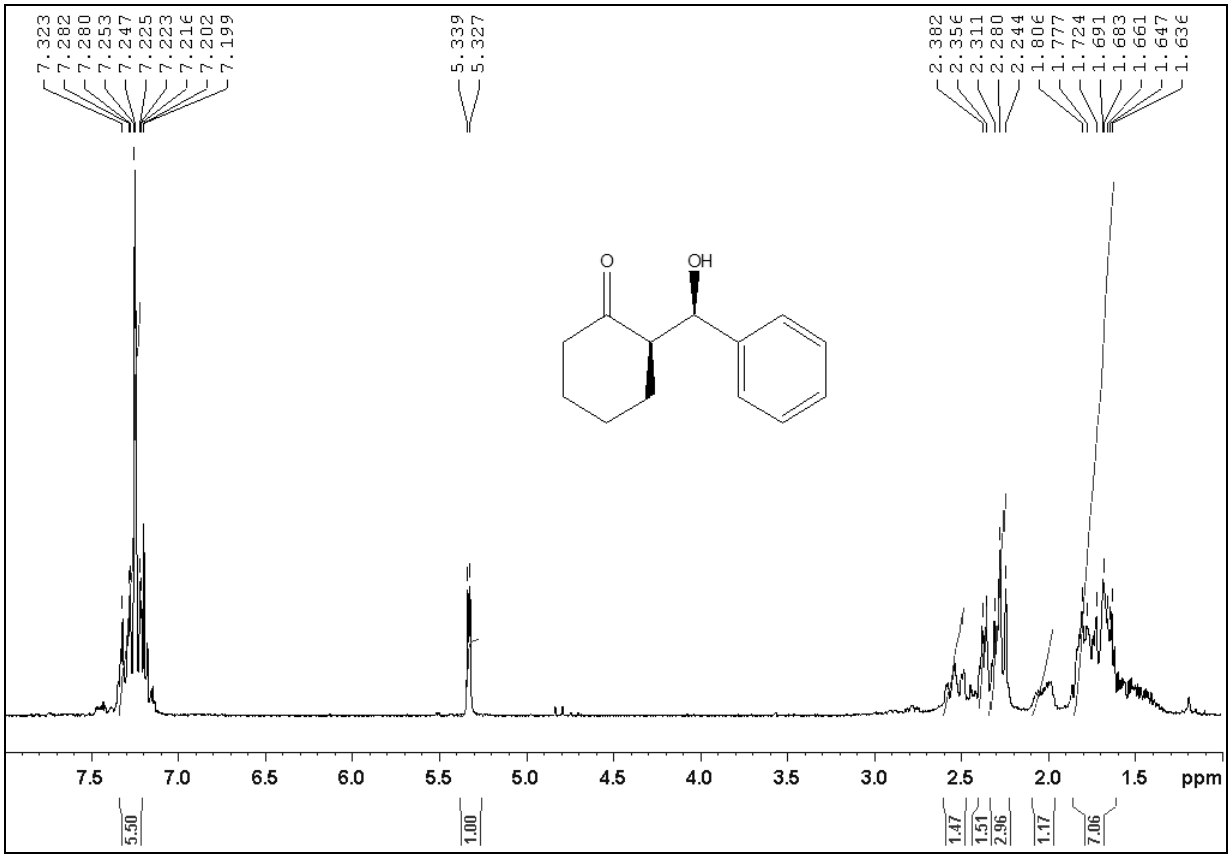


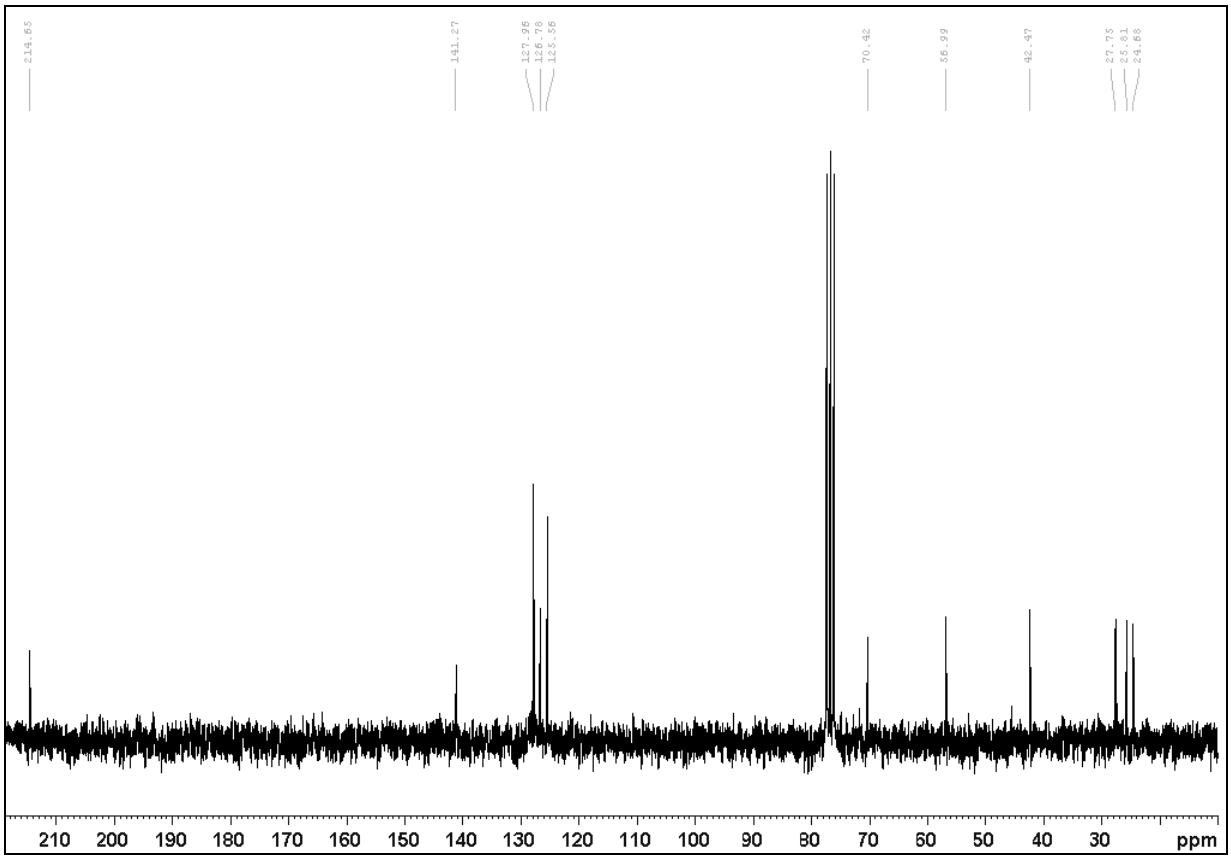
(*anti*)-2-[(4-Methoxyphenyl)(hydroxy)methyl]cyclohexan-1-one (6b).



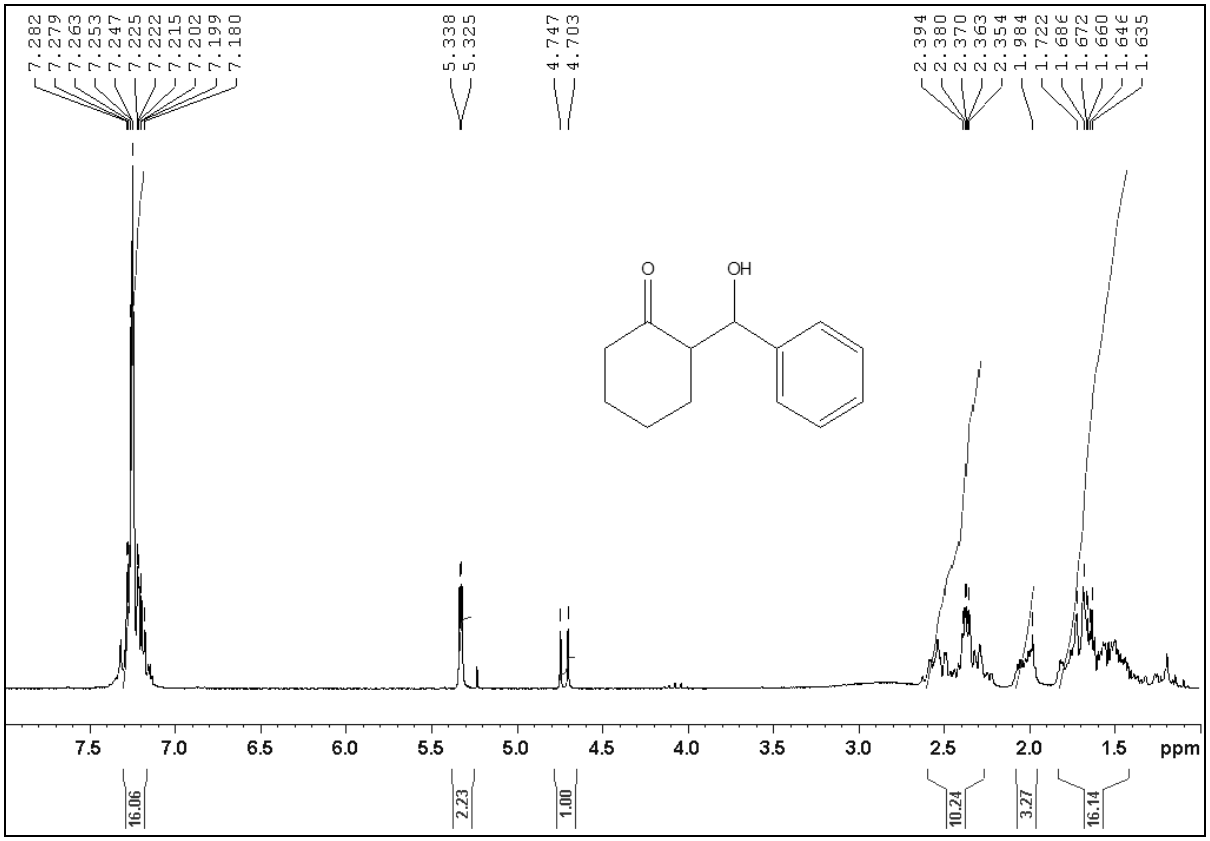


(*syn*)-2-[(Hydroxy)(phenyl)methyl]cyclohexan-1-one (6c).

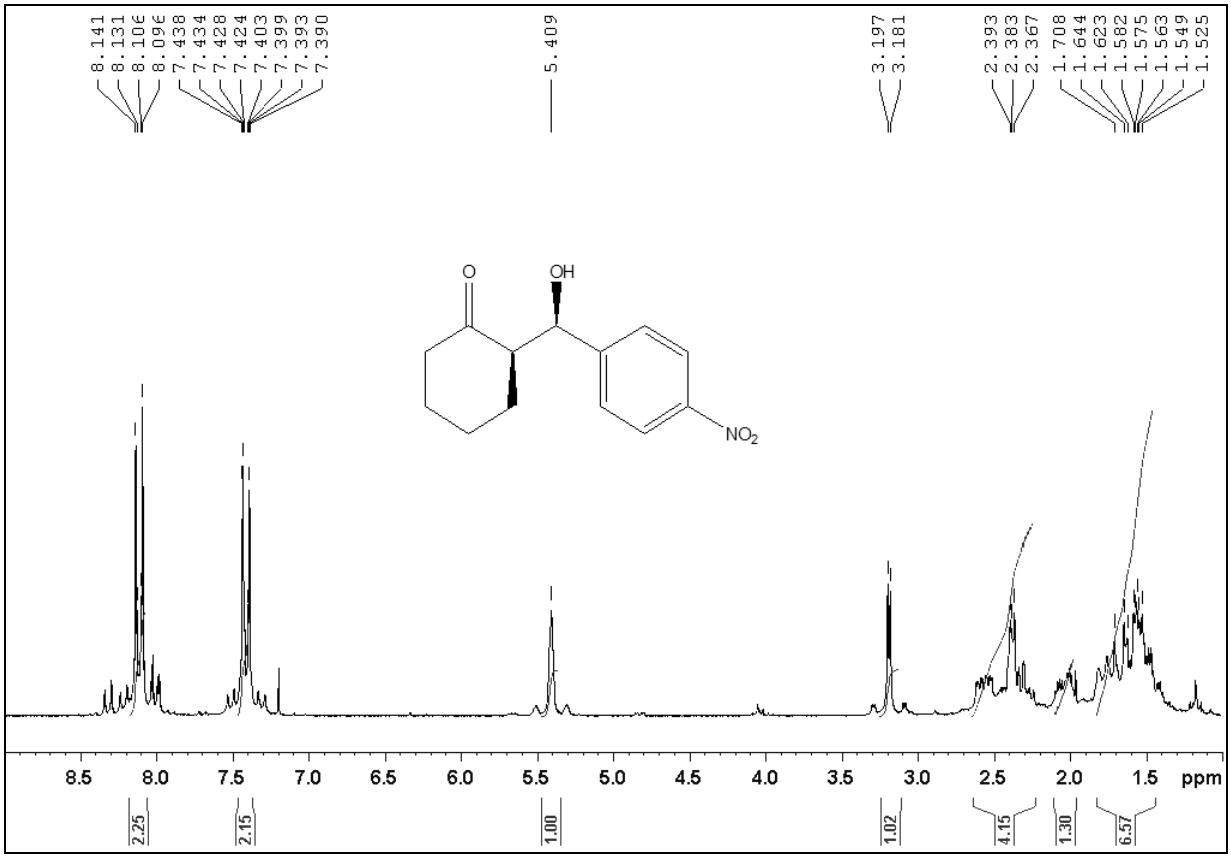


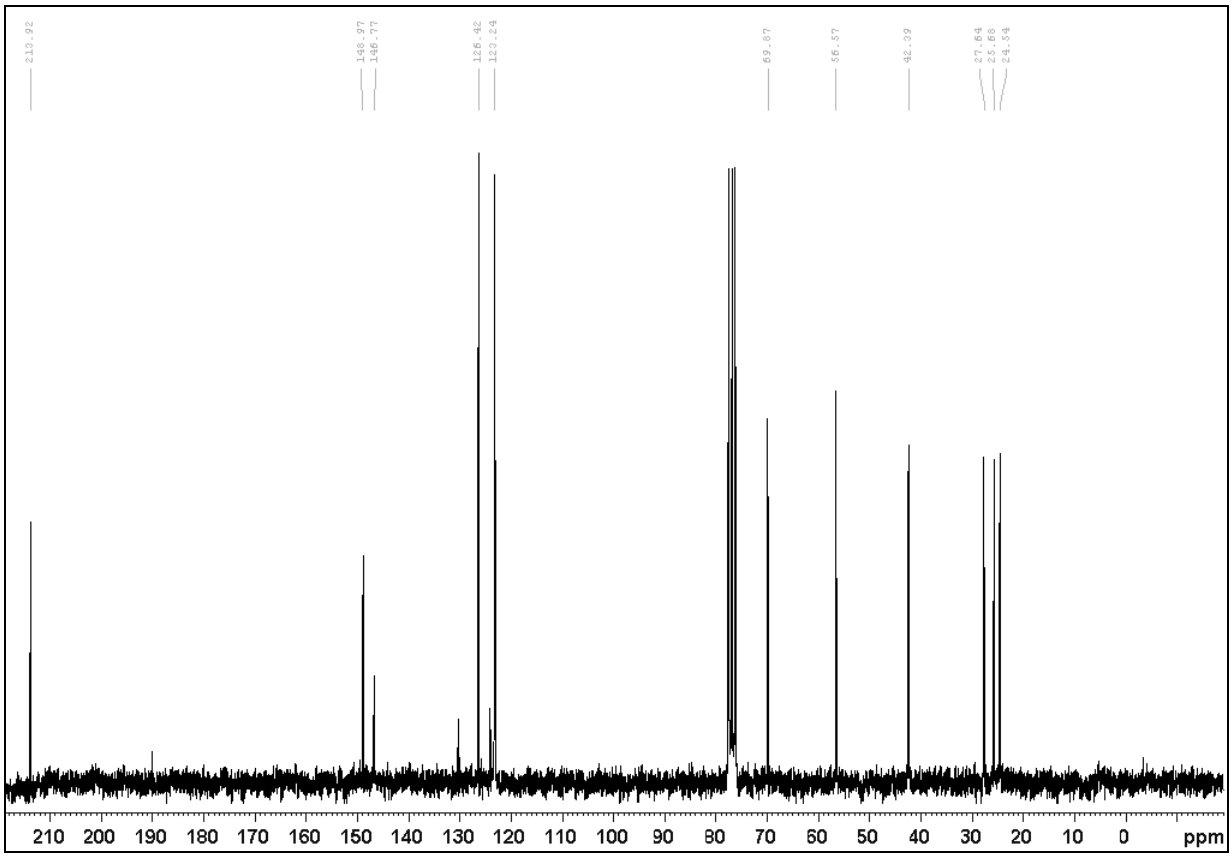


2-[(Hydroxy)(phenyl)methyl]cyclohexan-1-one (6c).

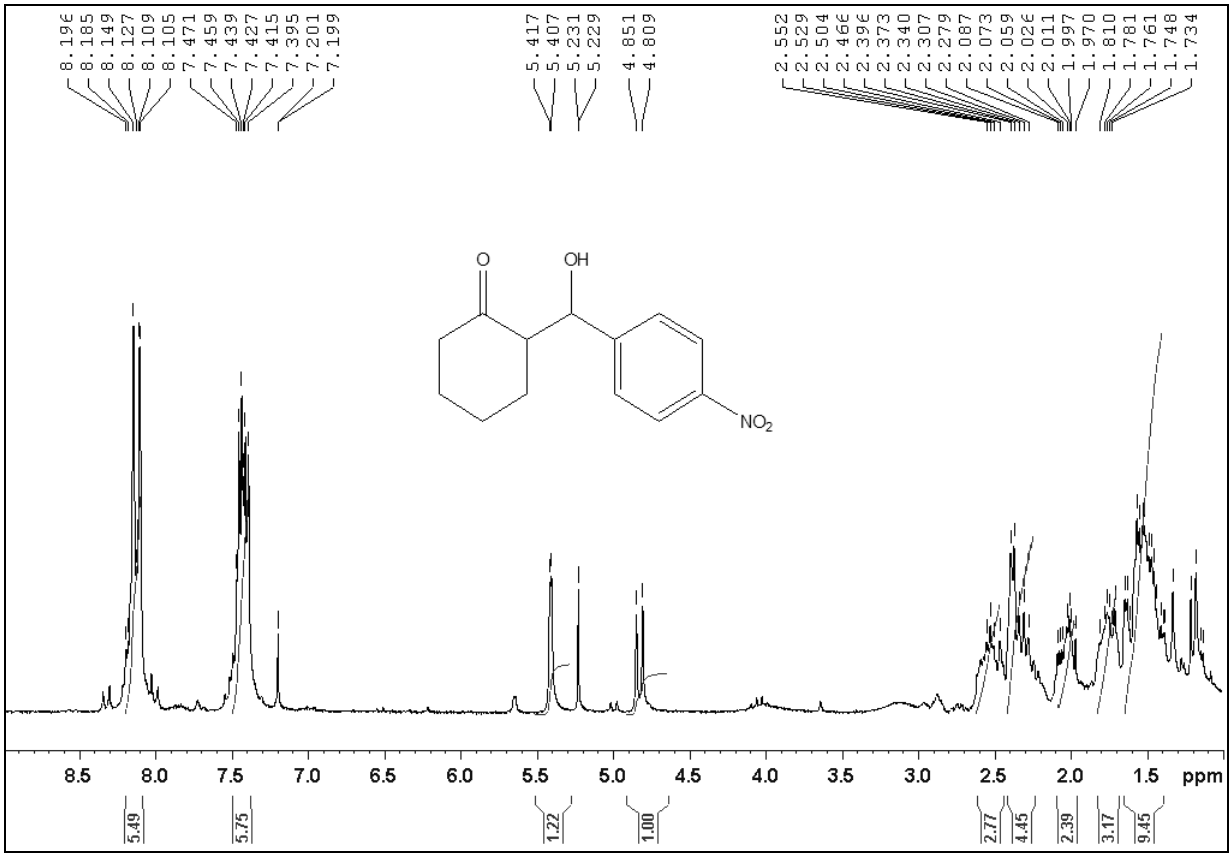


(*syn*)-2-[(Hydroxy)(4-nitrophenyl)methyl]cyclohexan-1-one (6d).

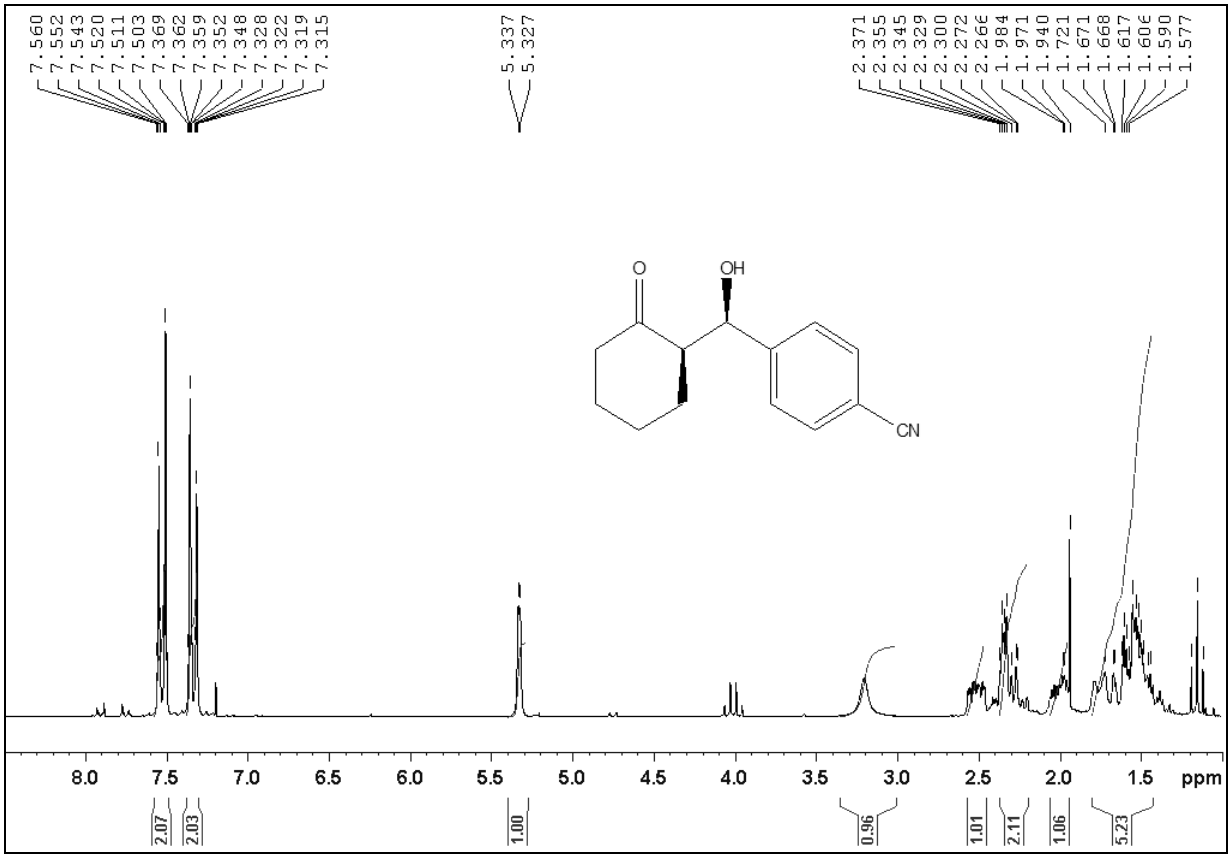


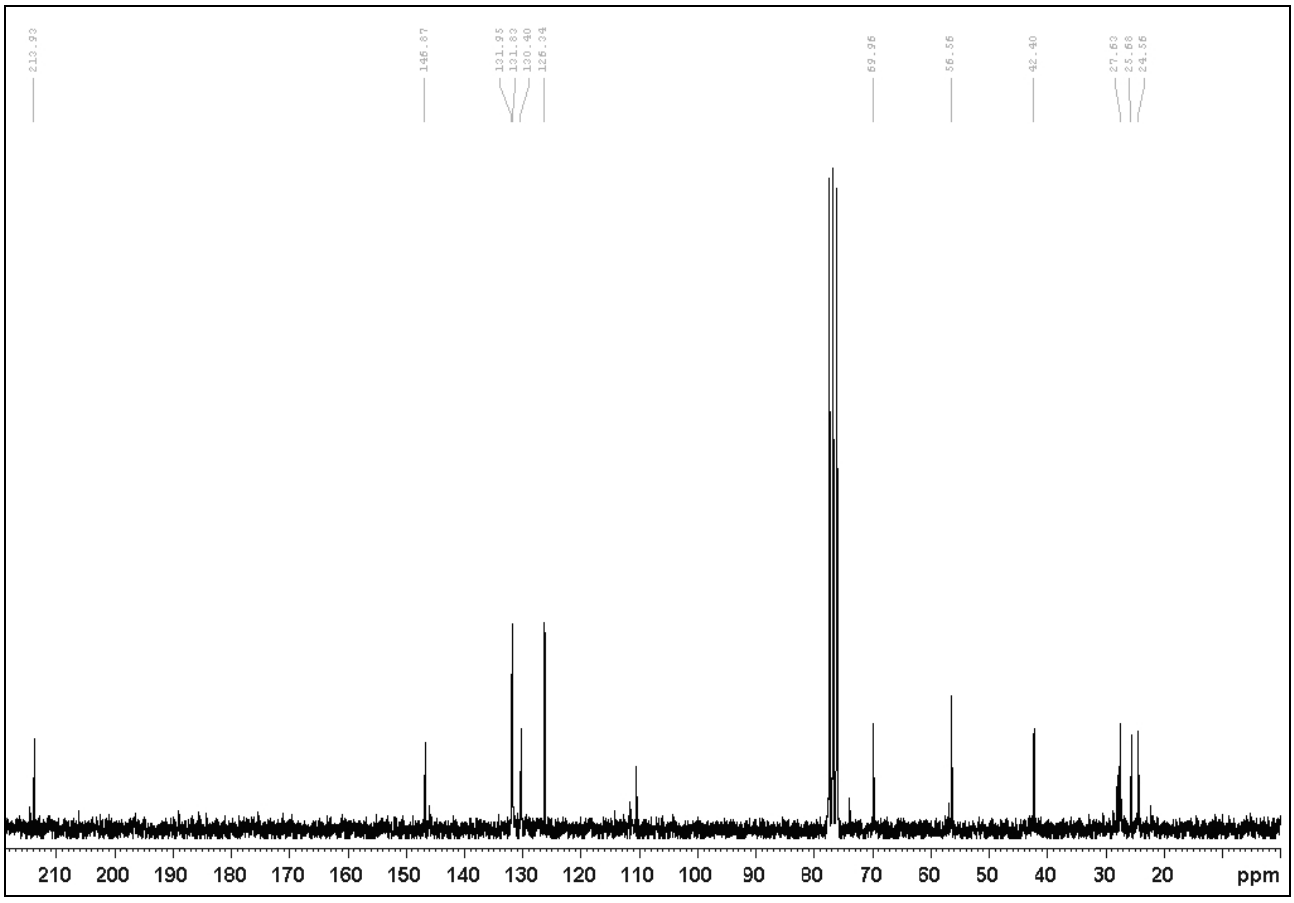


2-[(Hydroxy)(4-nitrophenyl)methyl]cyclohexan-1-one (6d).

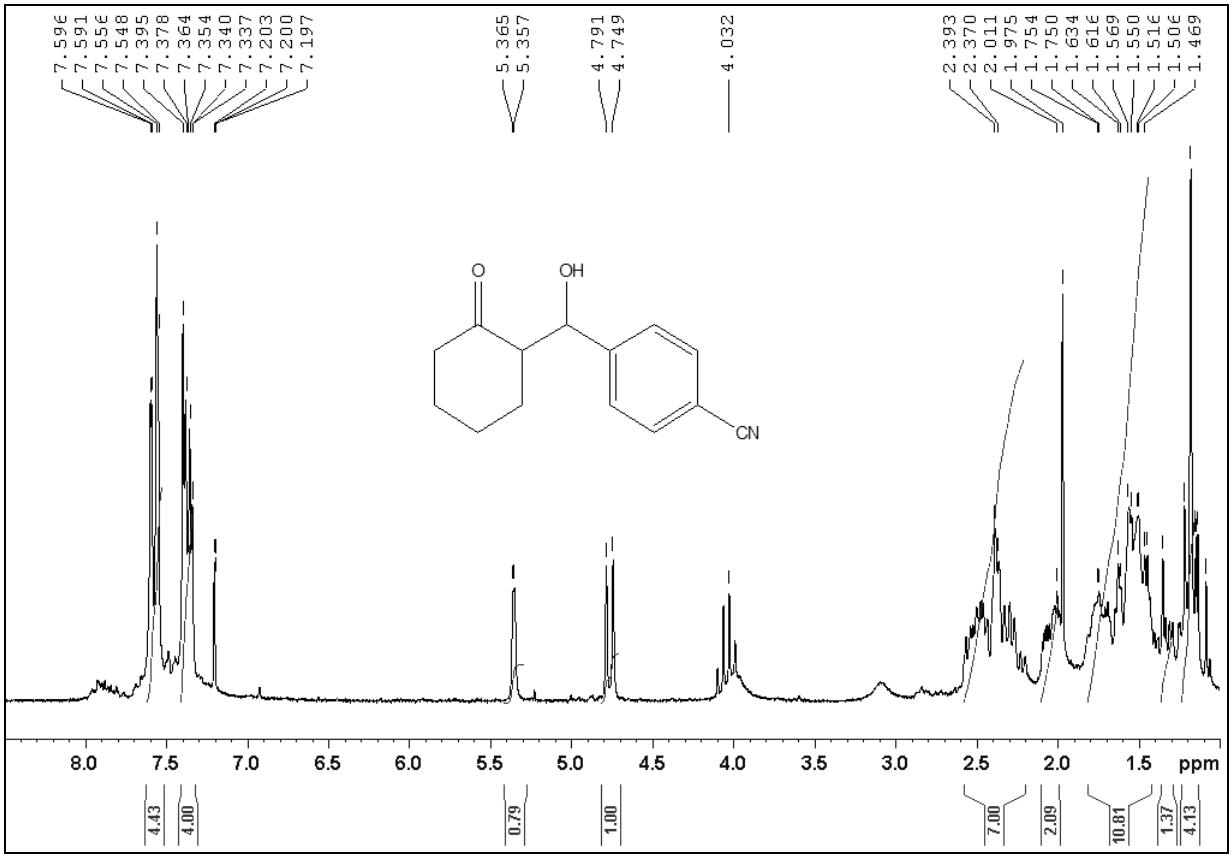


(*syn*)-2-[(Hydroxy)(4-cyanophenyl)methyl]cyclohexan-1-one (6e).

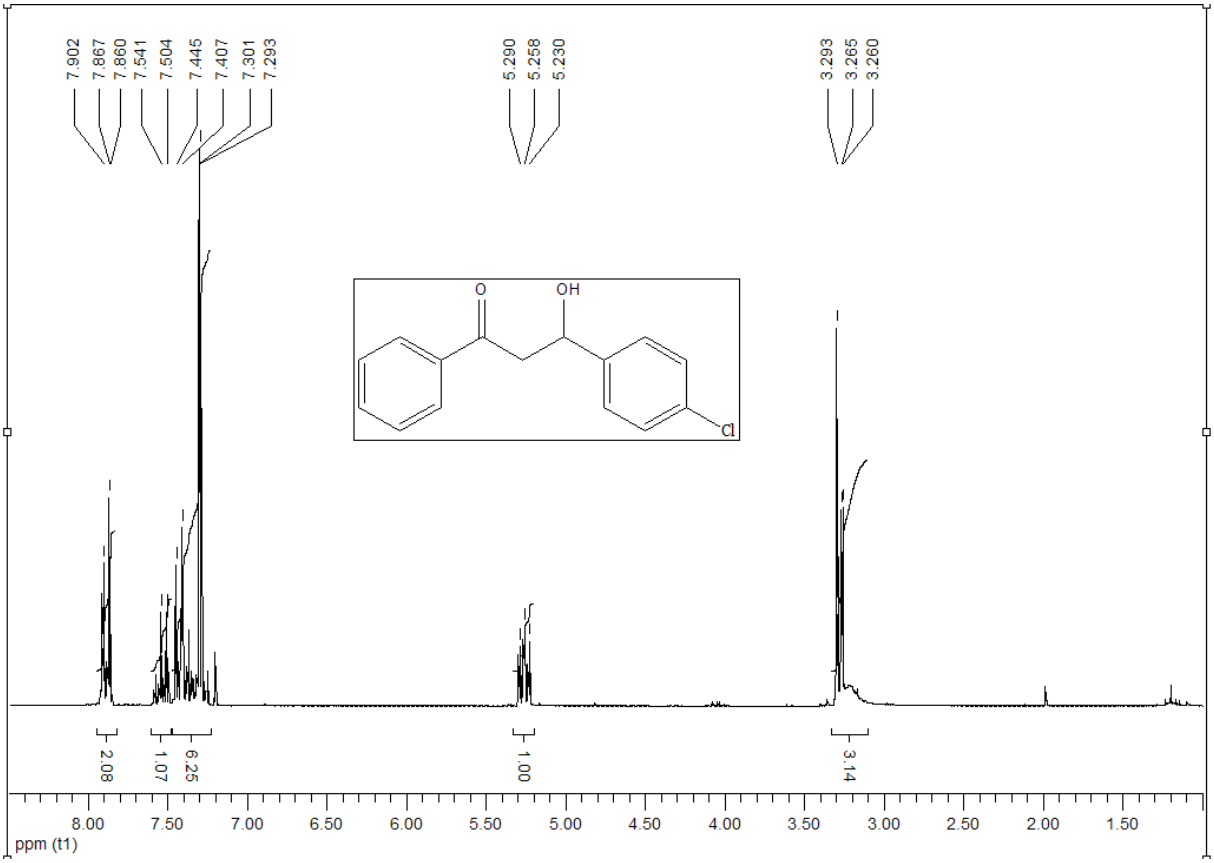


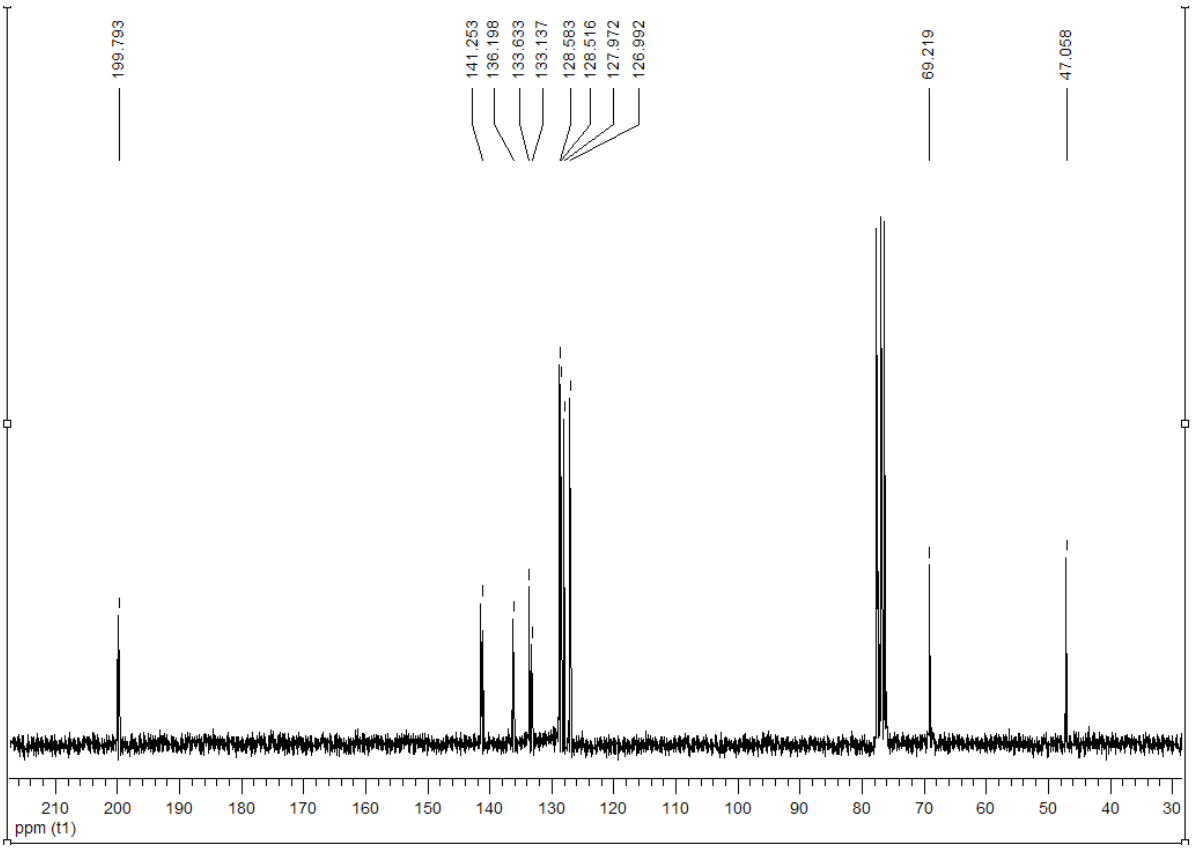


2-[(Hydroxy)(4-cyanophenyl)methyl]cyclohexan-1-one (6e).

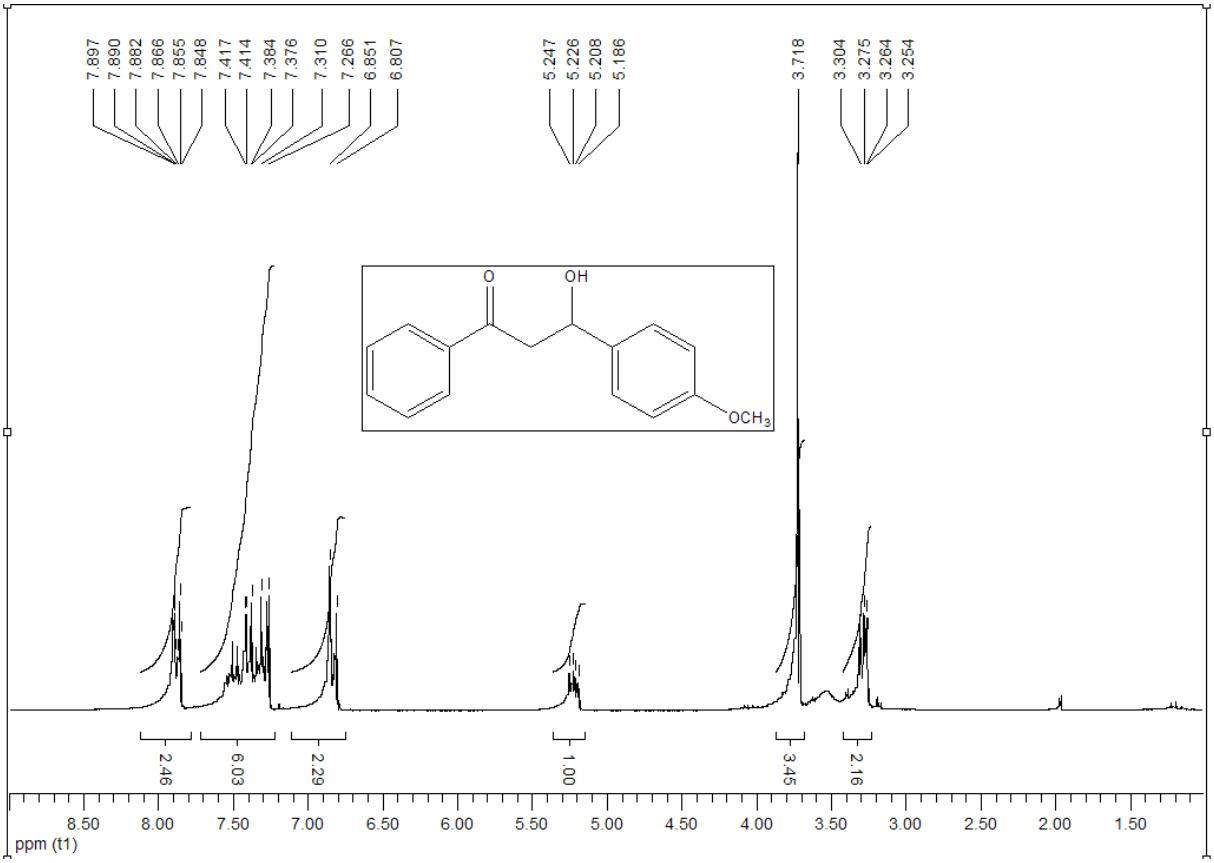


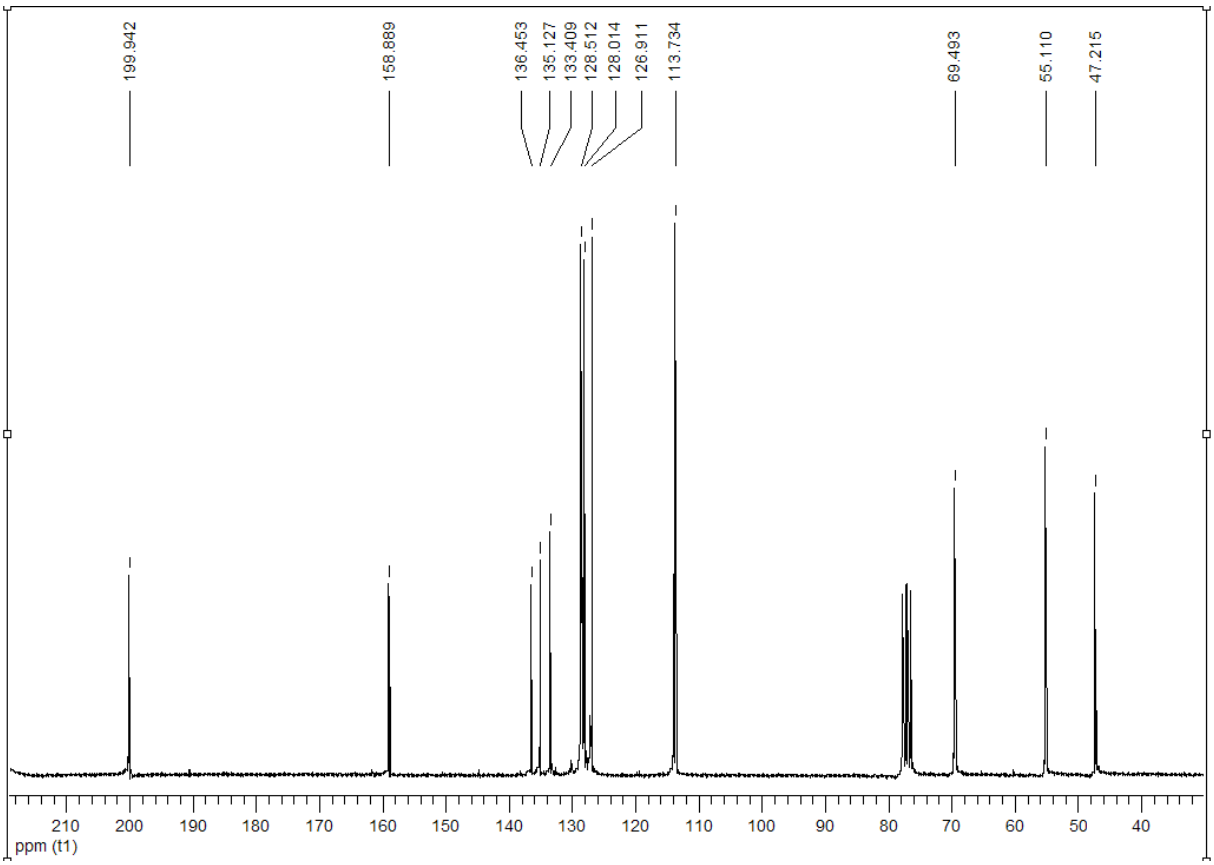
3-(4-Chlorophenyl)-3-hydroxy-1-phenylpropan-1-one (9a).



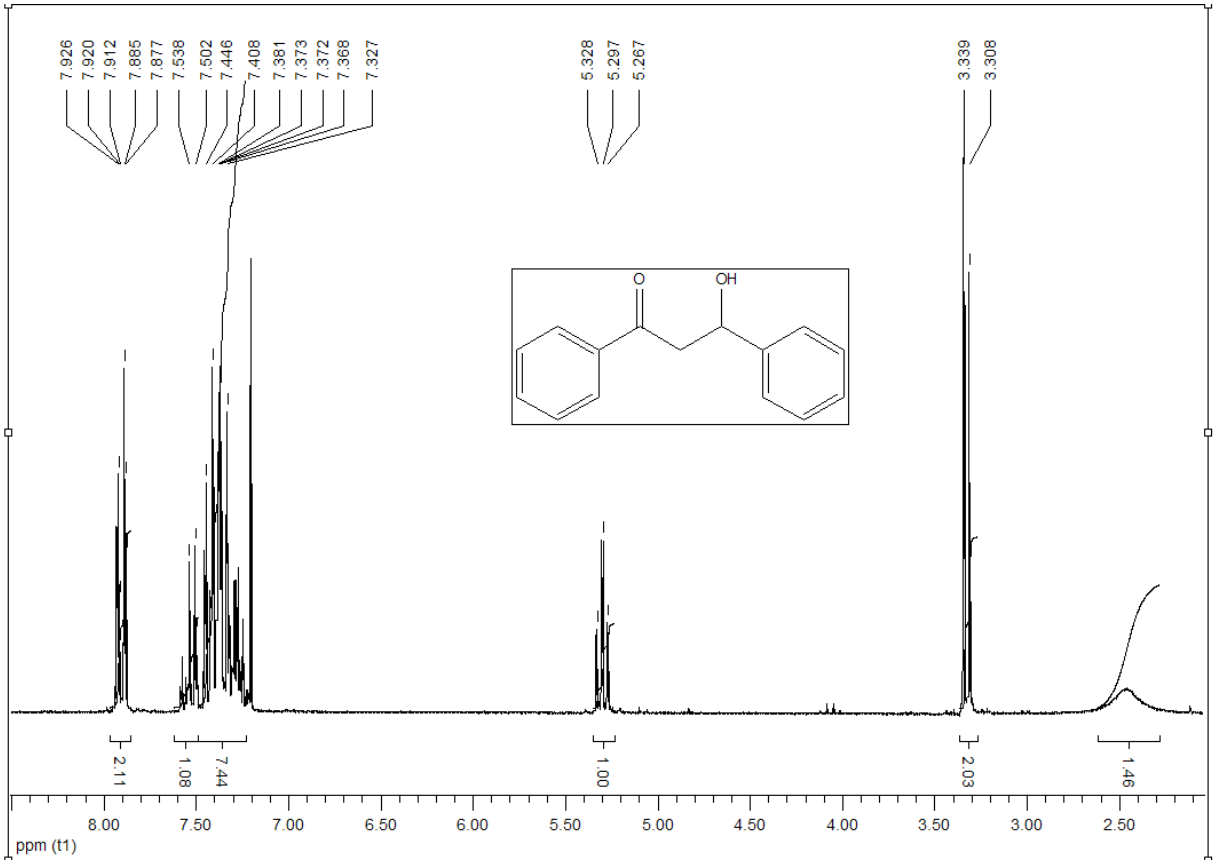


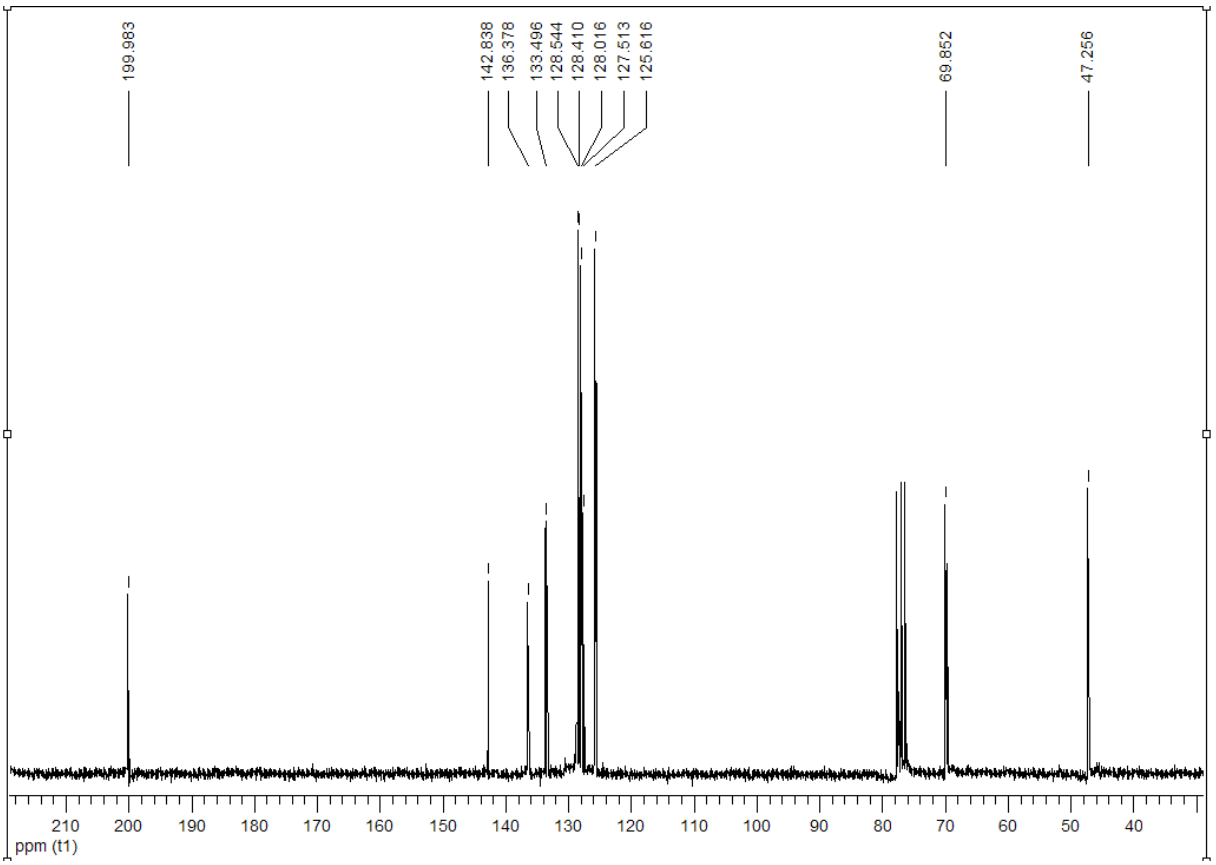
3-Hydroxy-3-(4-methoxyphenyl)-1-phenylpropan-1-one (9b).



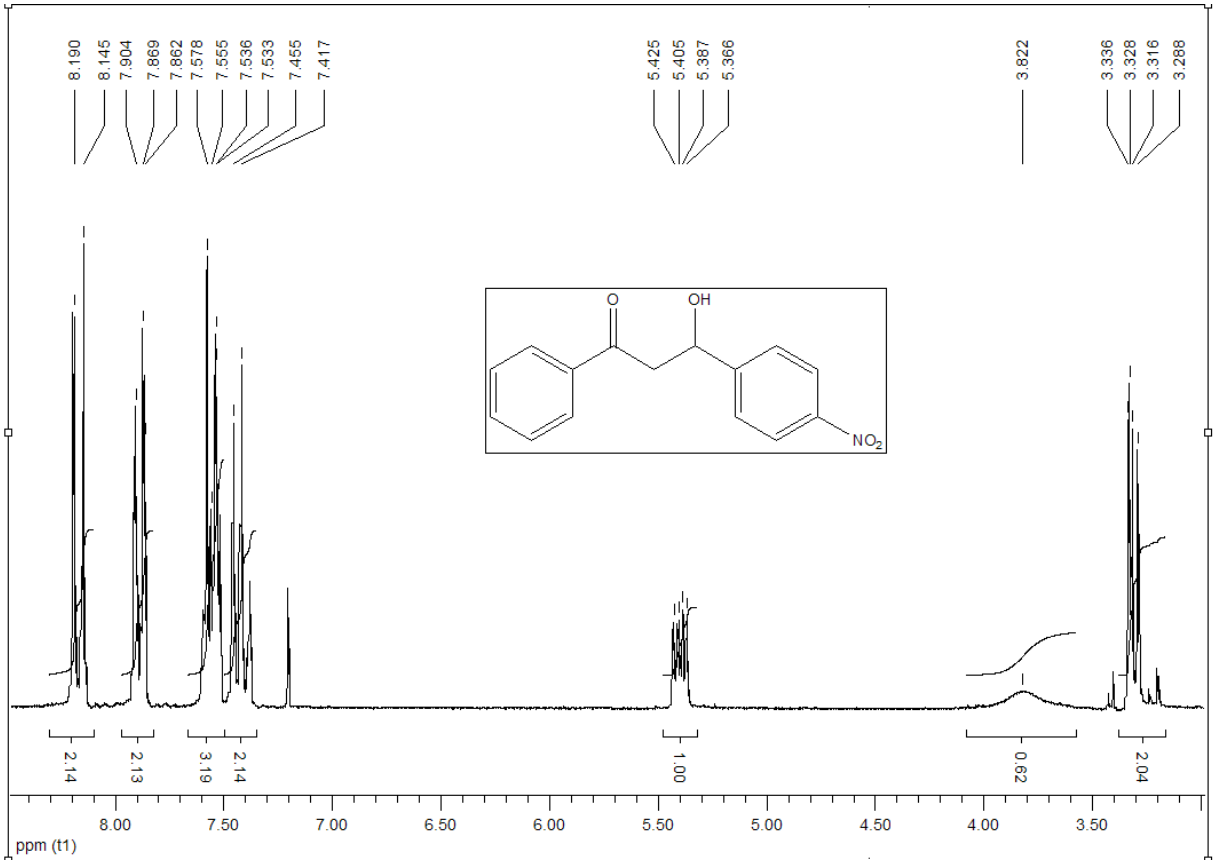


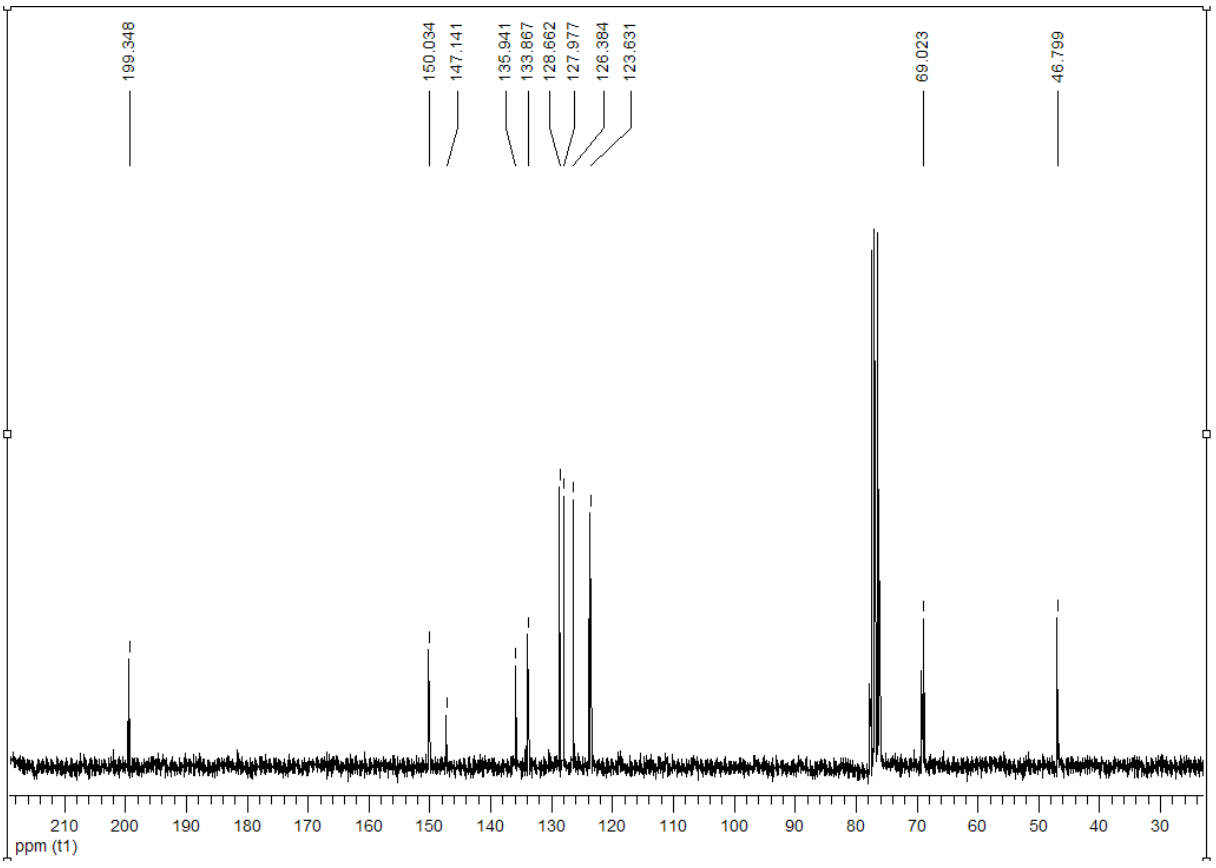
3-Hydroxy-1,3-diphenylpropan-1-one (9c).



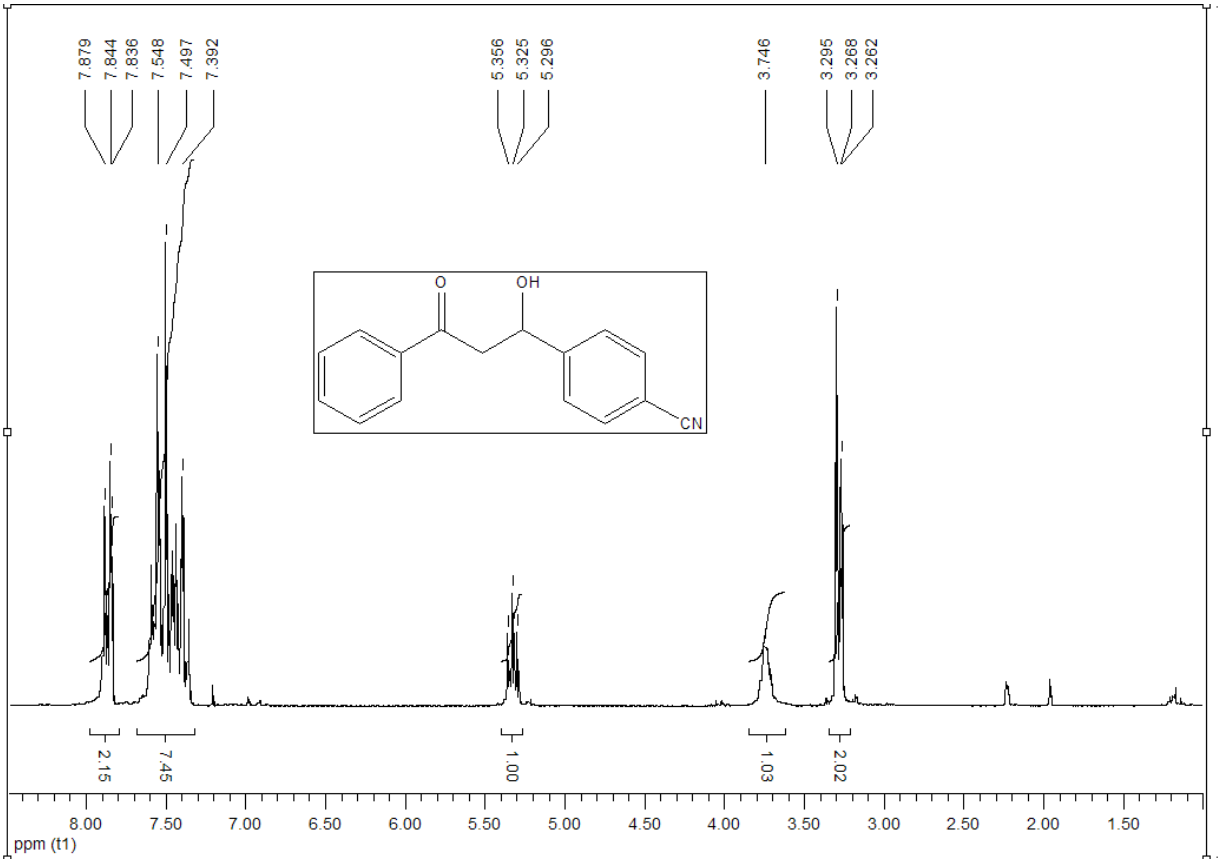


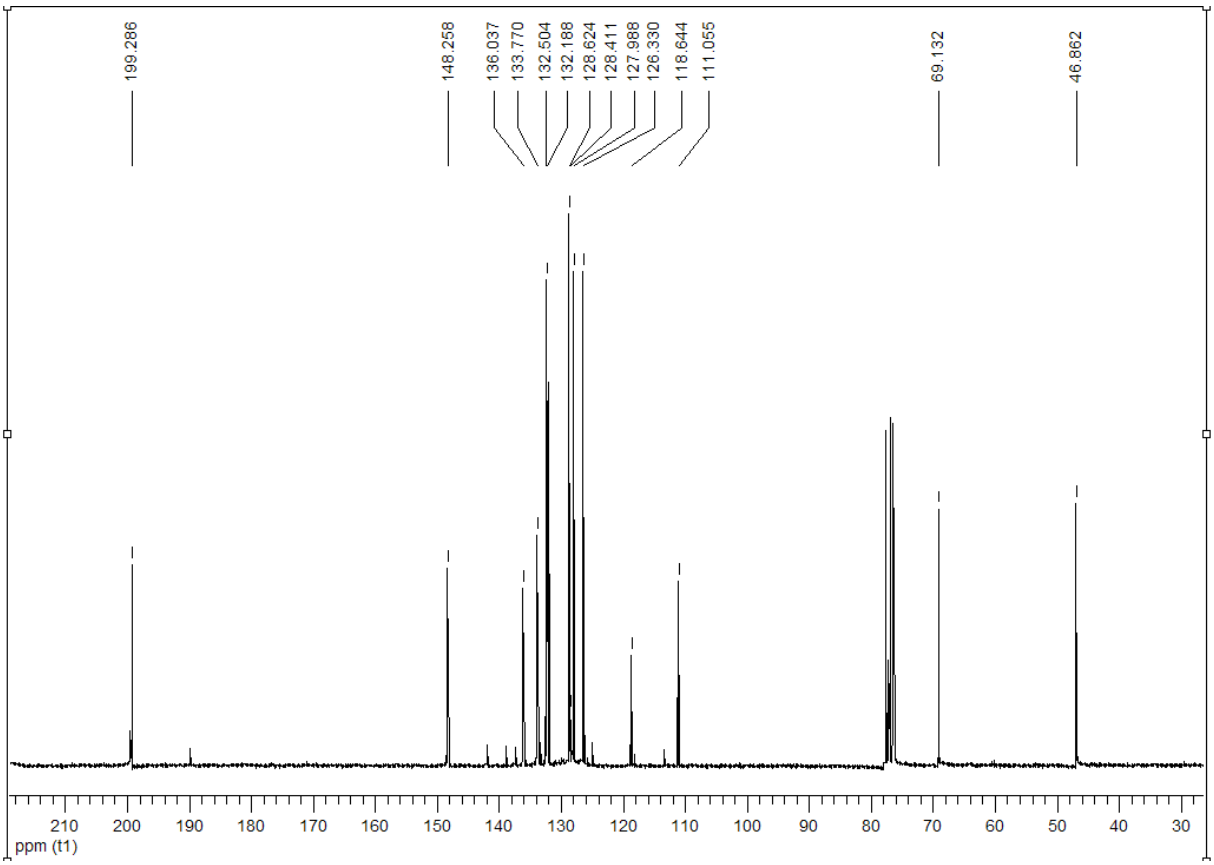
3-Hydroxy-3-(4-nitrophenyl)-1-phenylpropan-1-one (9d).[8,9,6]



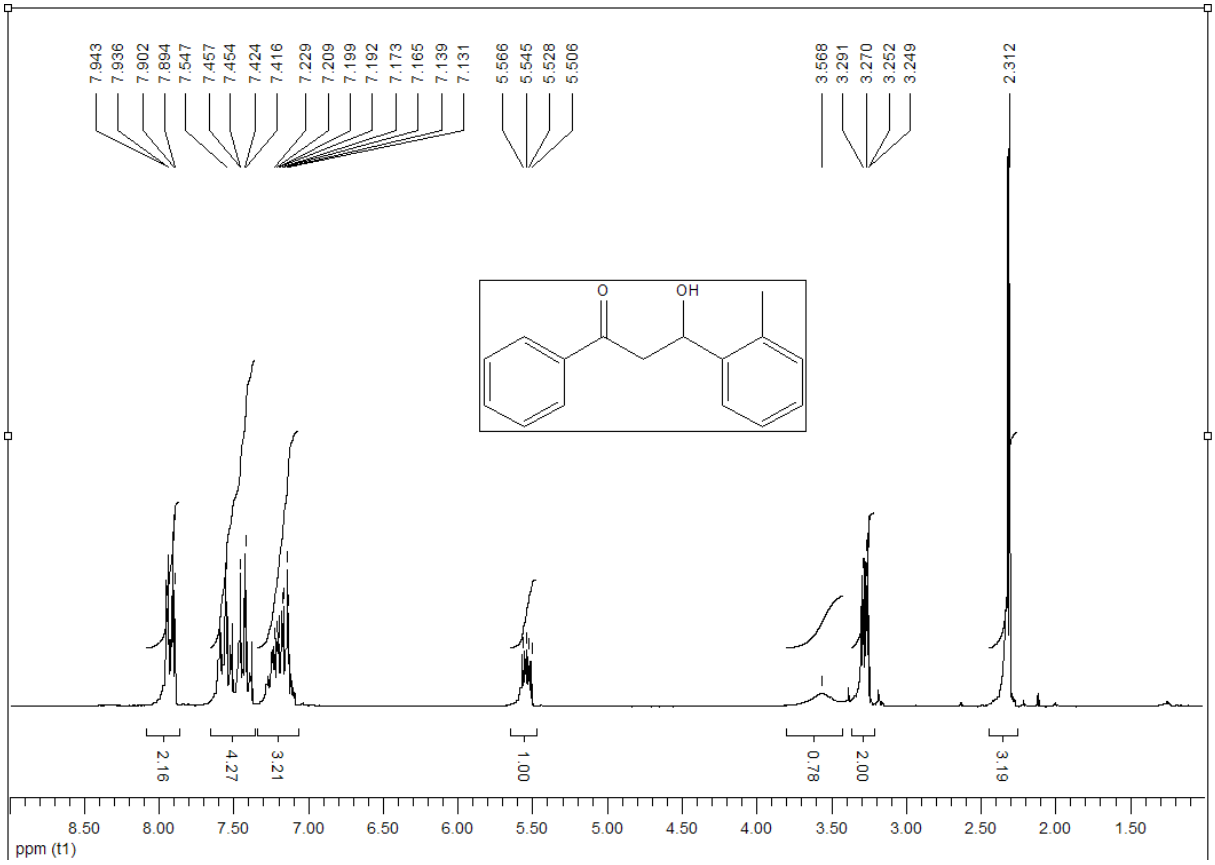


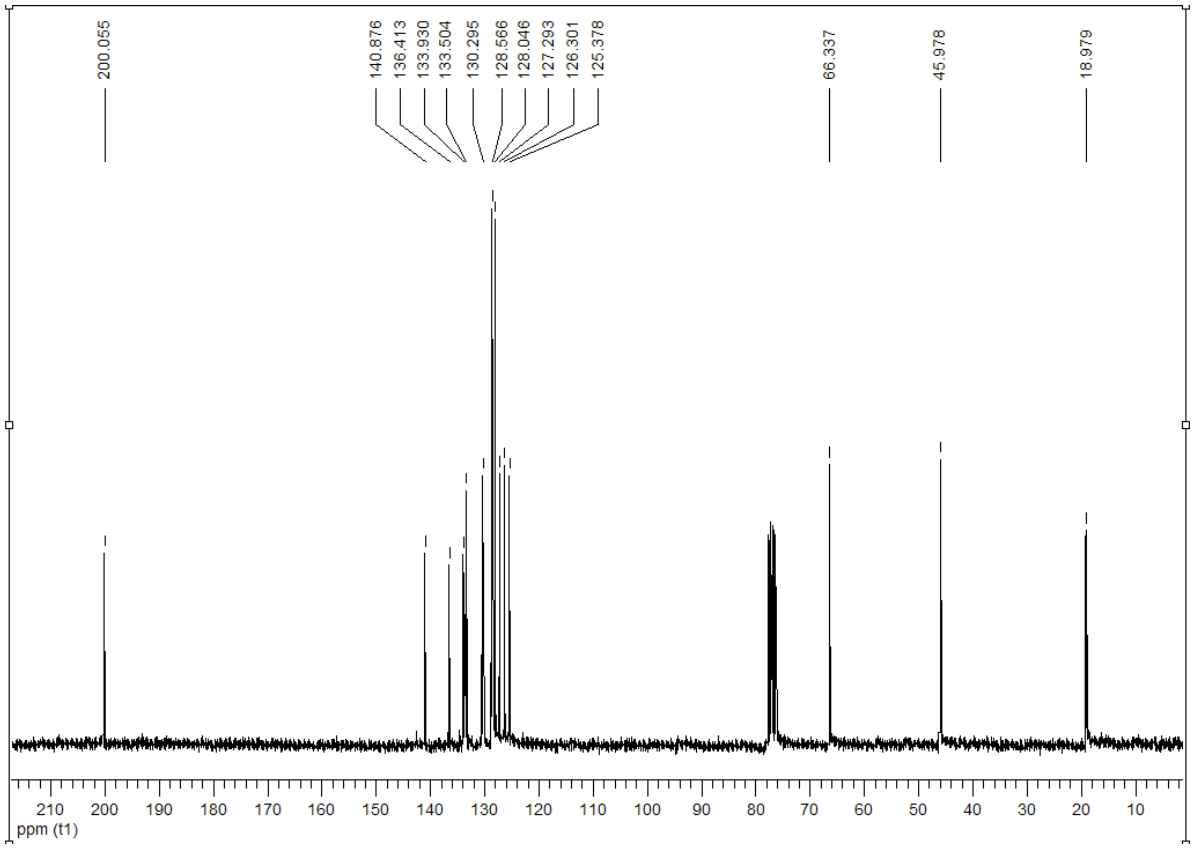
3-(4-Cyanophenyl)-3-hydroxy-1-phenylpropan-1-one (9e).



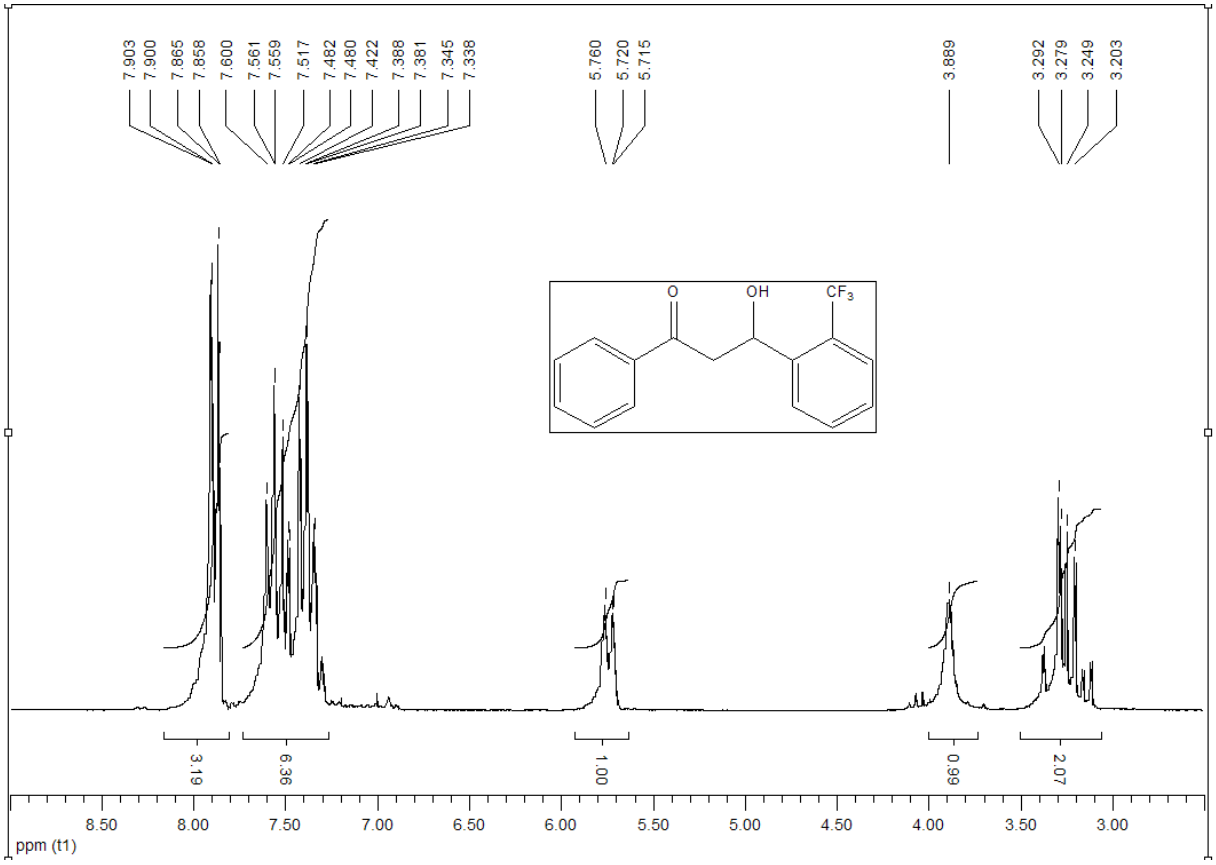


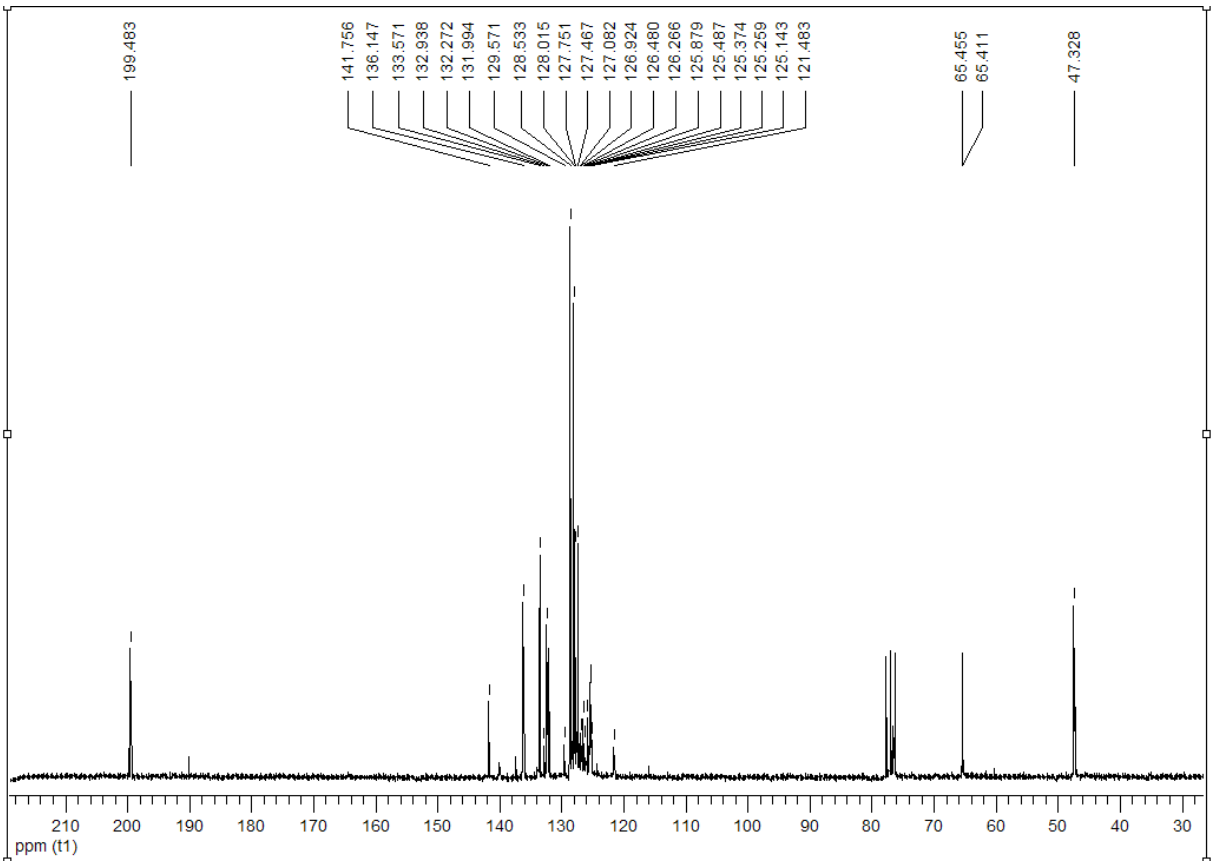
3-Hydroxy-3-(2-tolyl)-1-phenylpropan-1-one (9f).



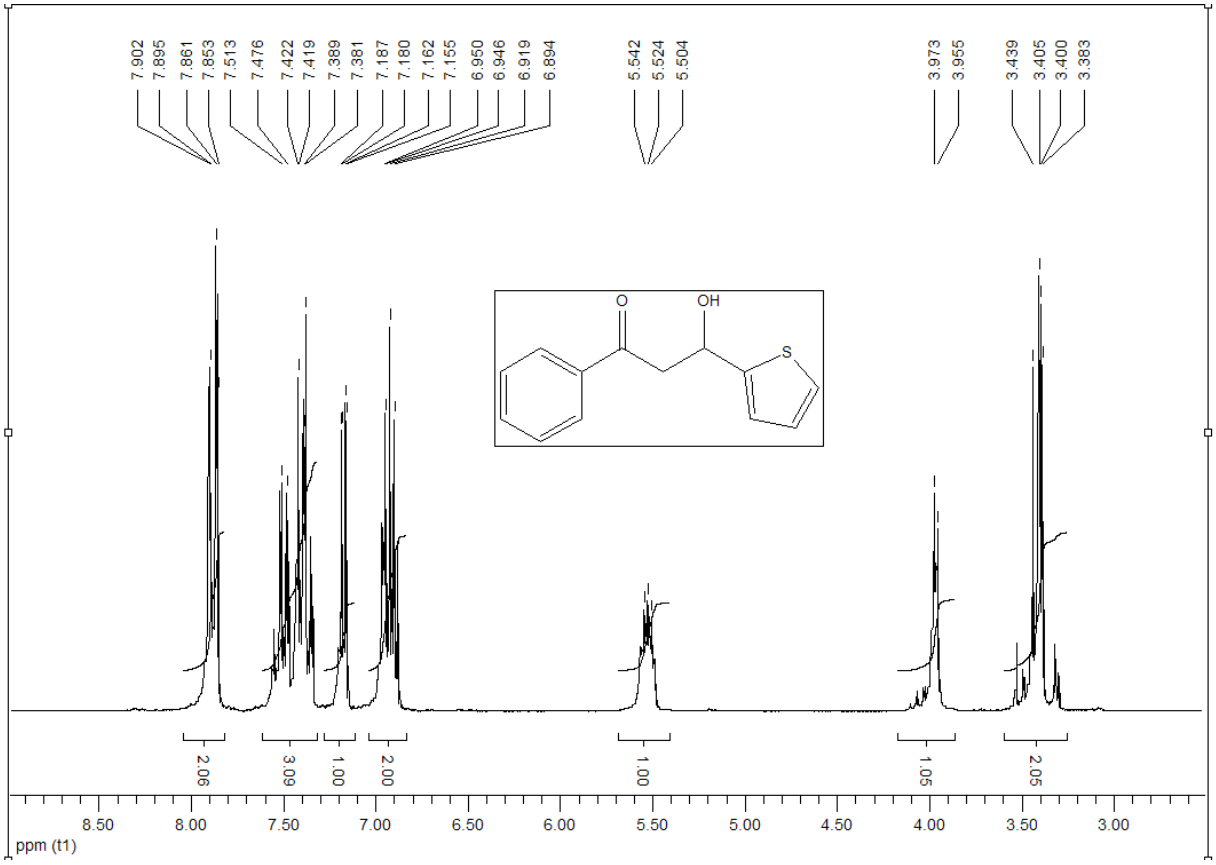


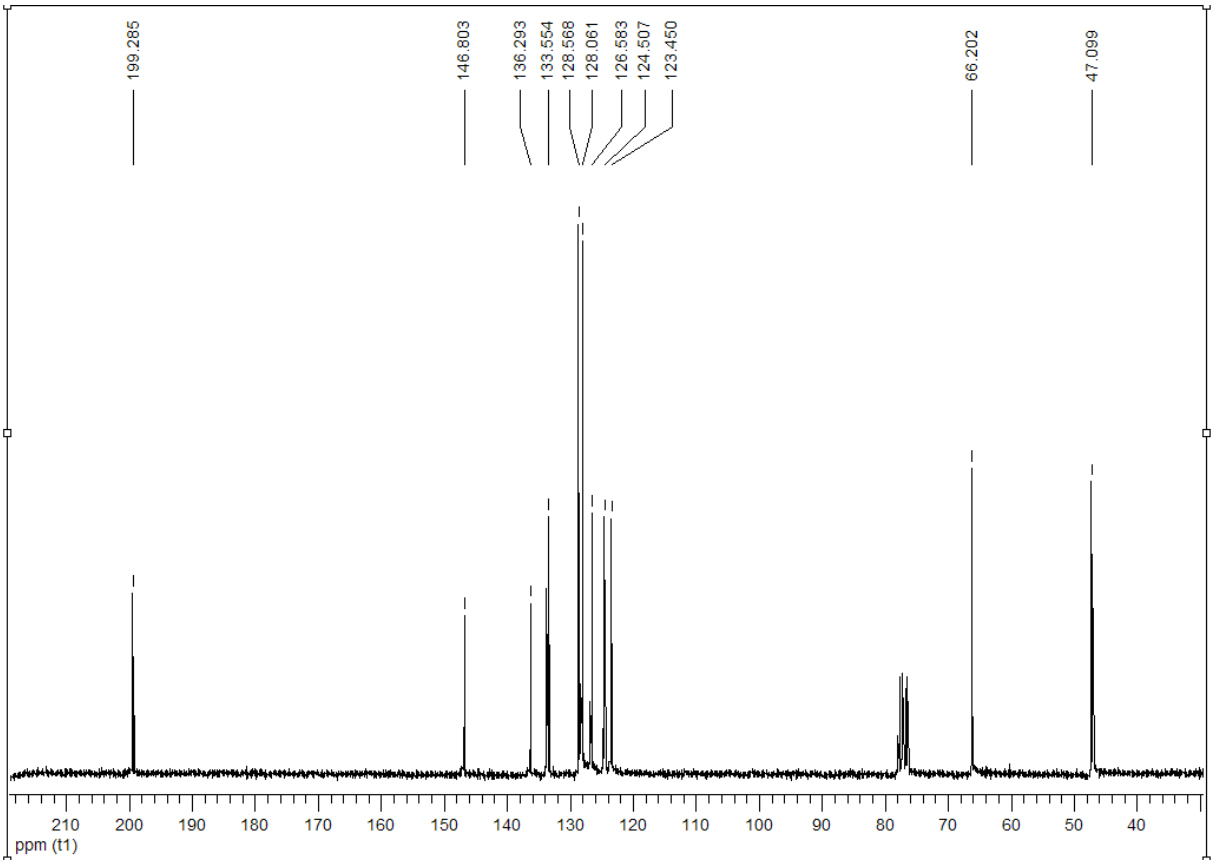
3-Hydroxy-1-phenyl-3-(2-trifluoromethylphenyl)propan-1-one (9g).



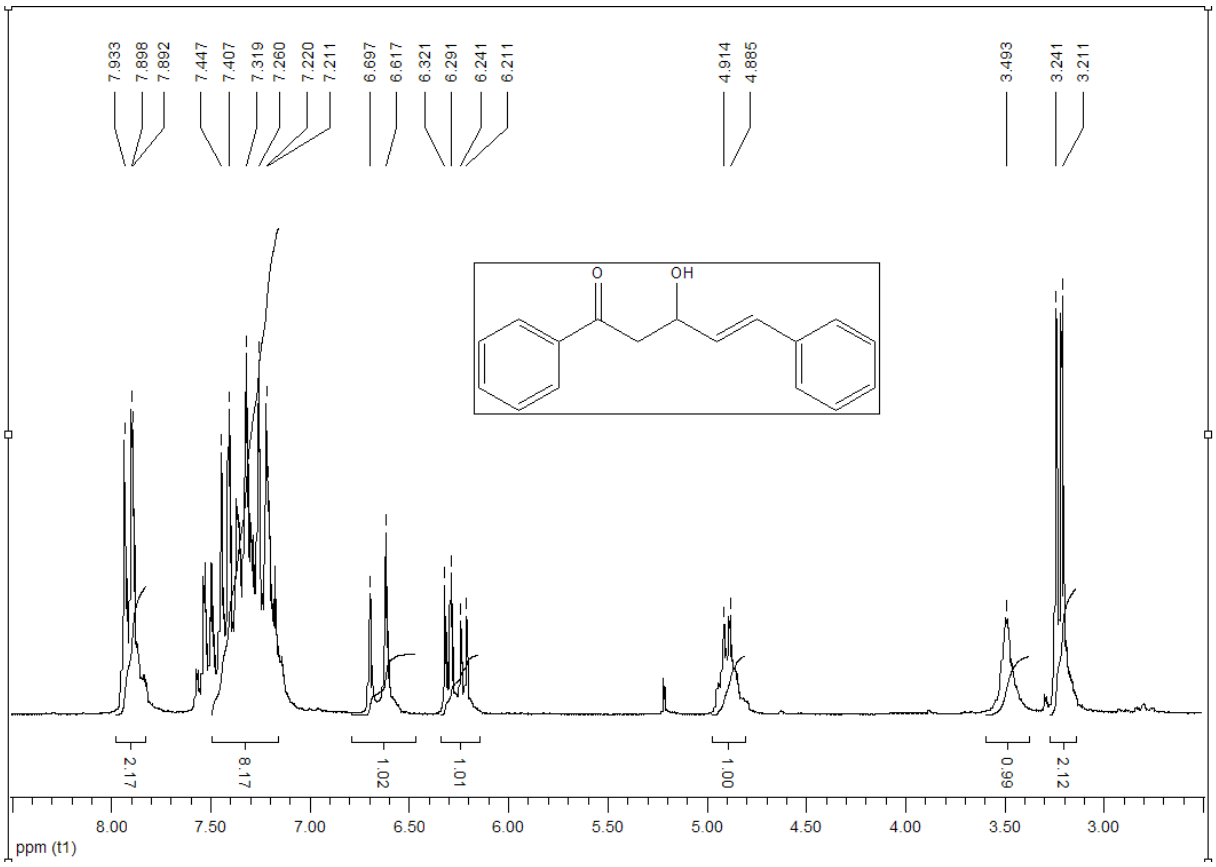


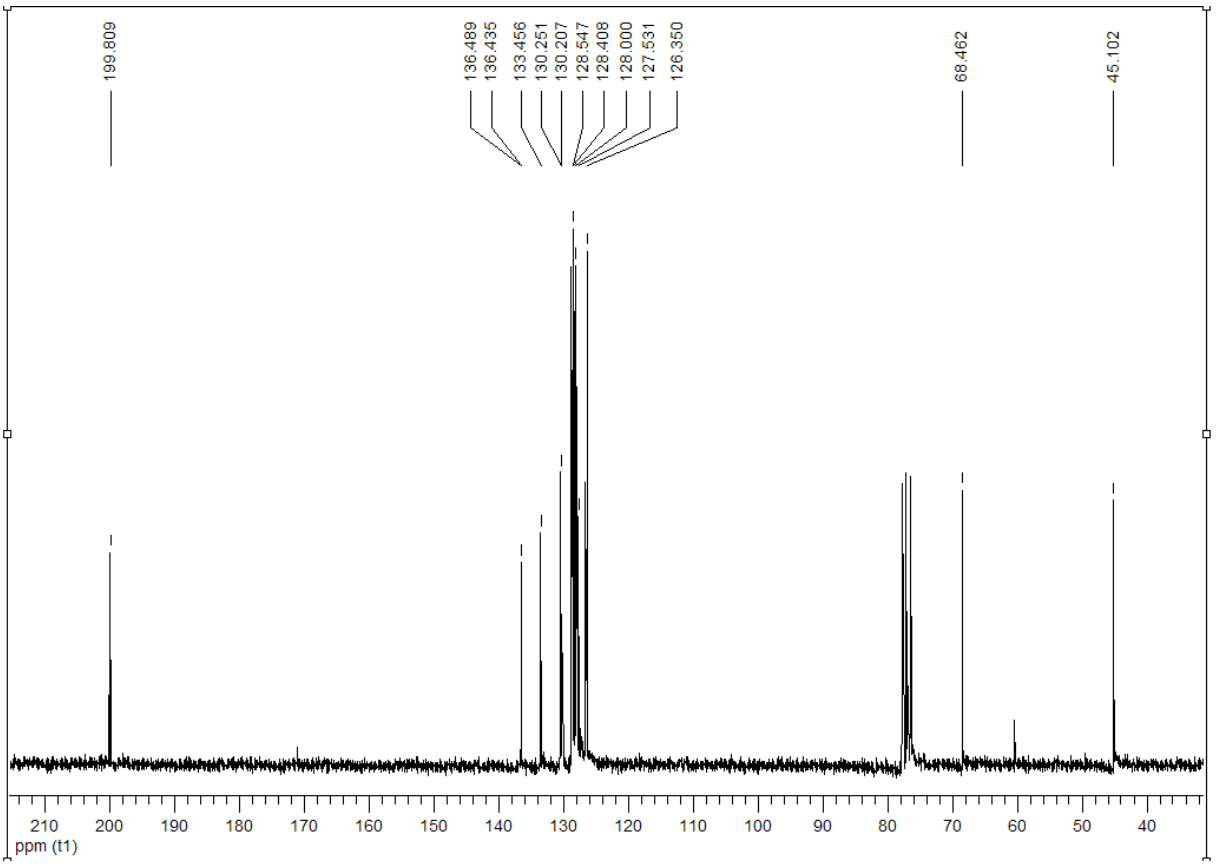
3-Hydroxy-3-(2-thienyl)-1-phenylpropan-1-one (9h).



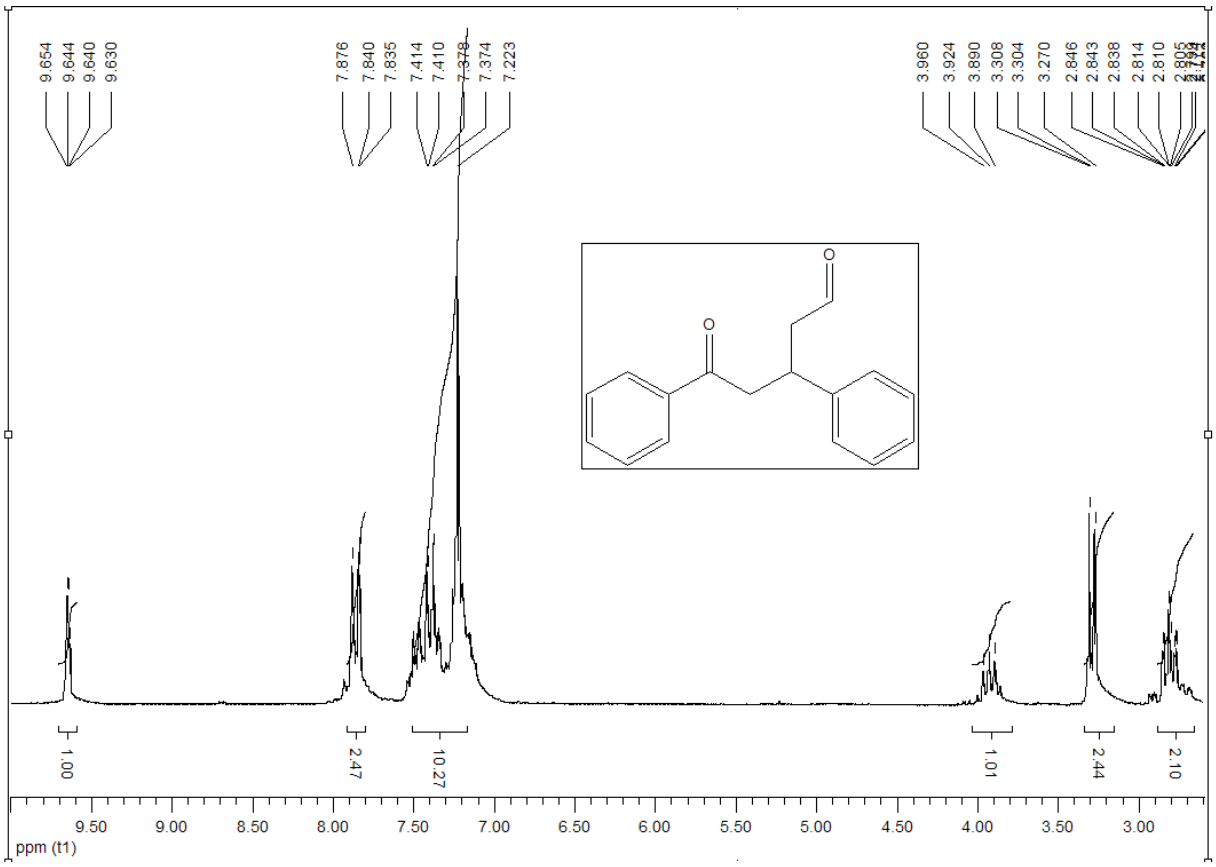


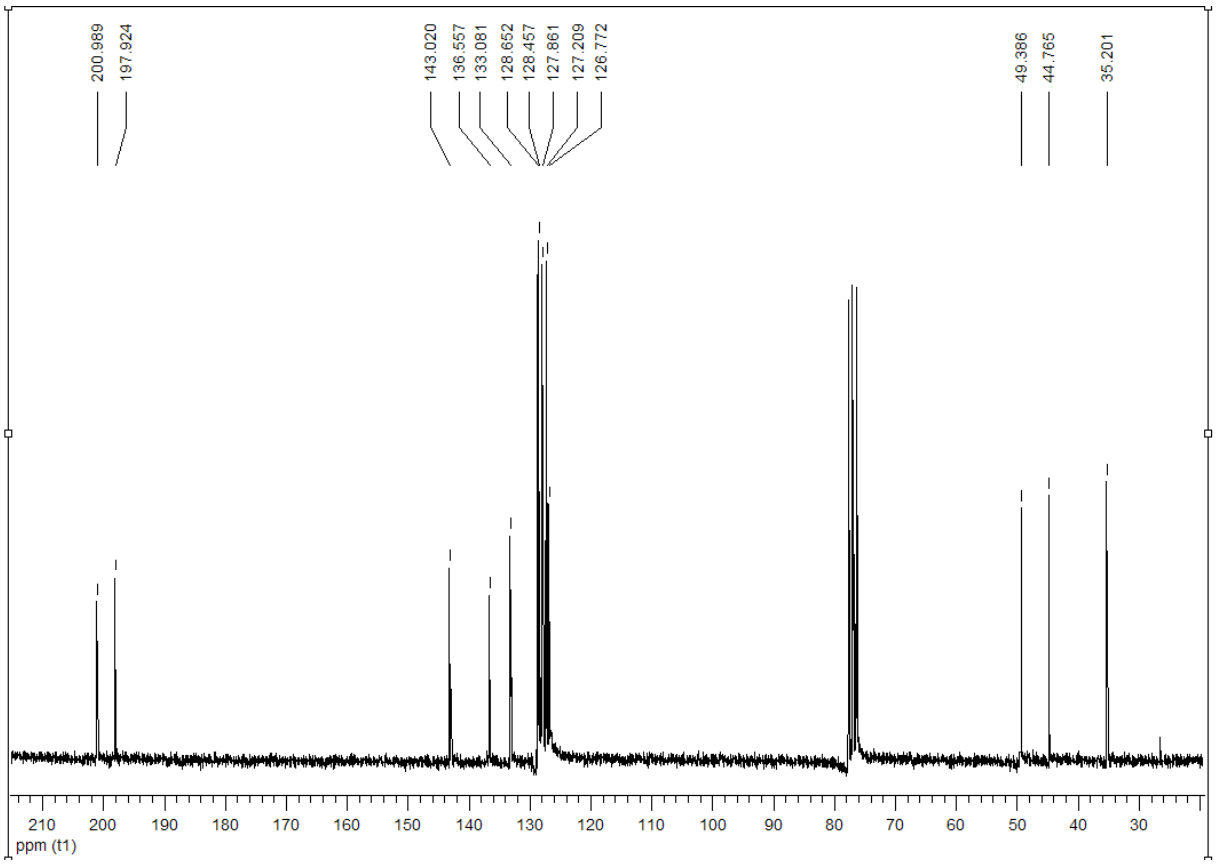
(*trans*)-3-Hydroxy-1,5-diphenylpent-4-en-1-one (9i).



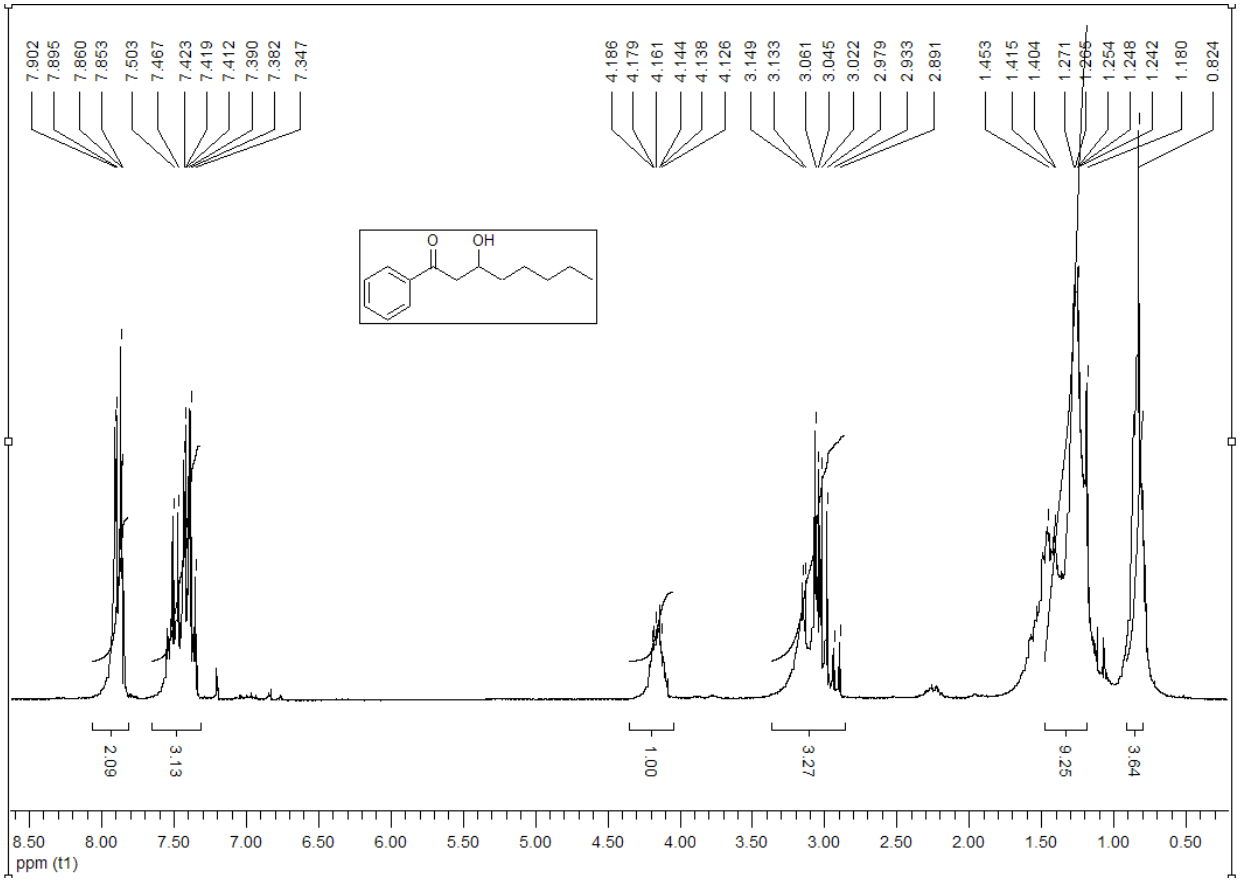


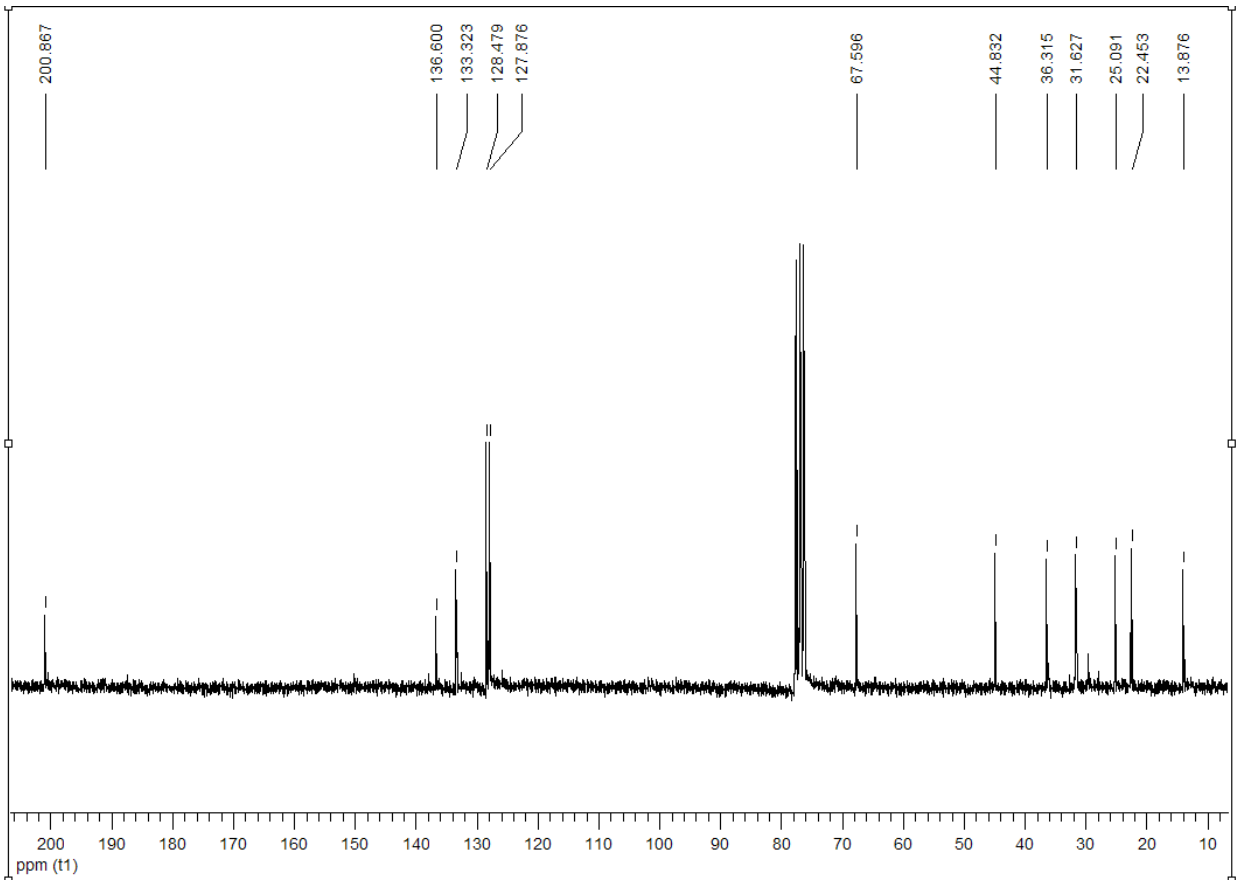
5-Oxo-3,5-diphenylpentanal (10)



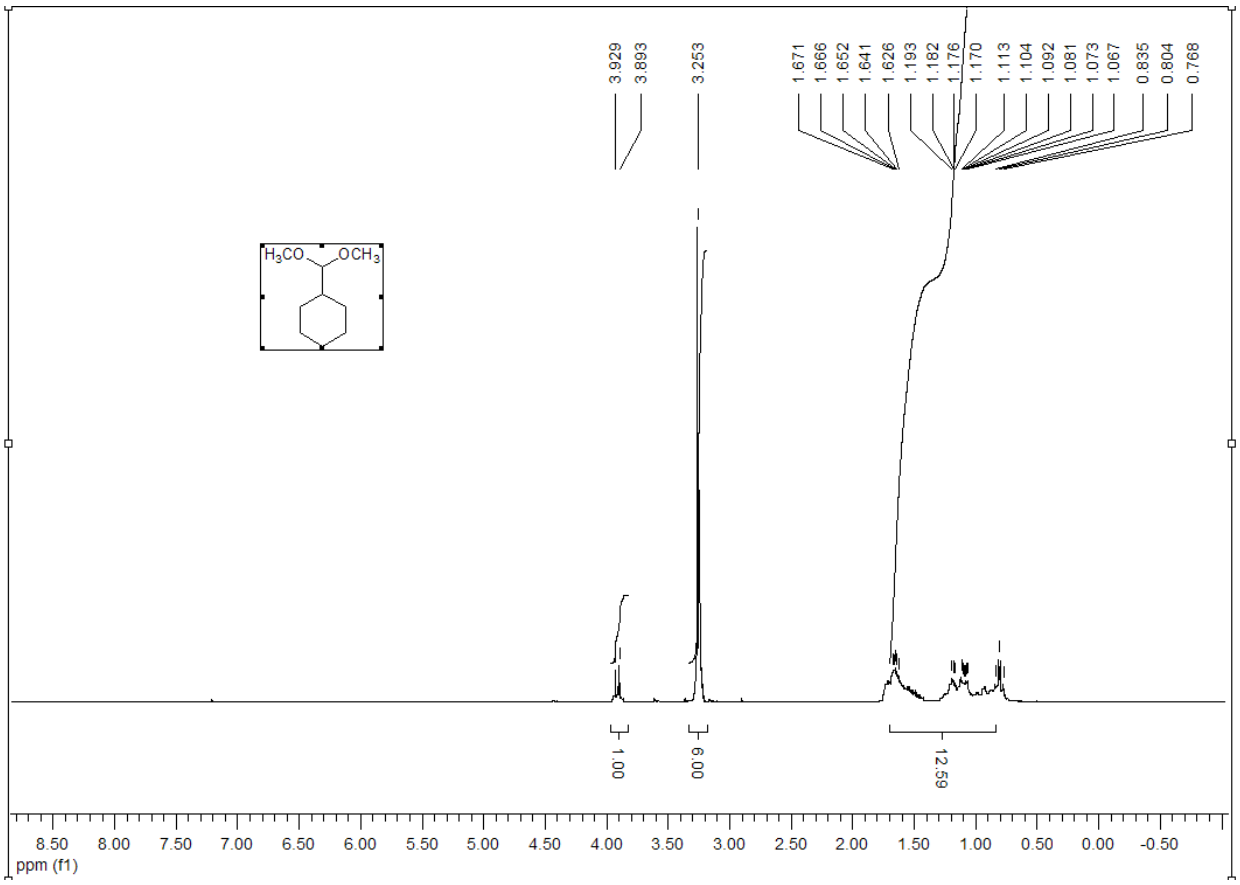


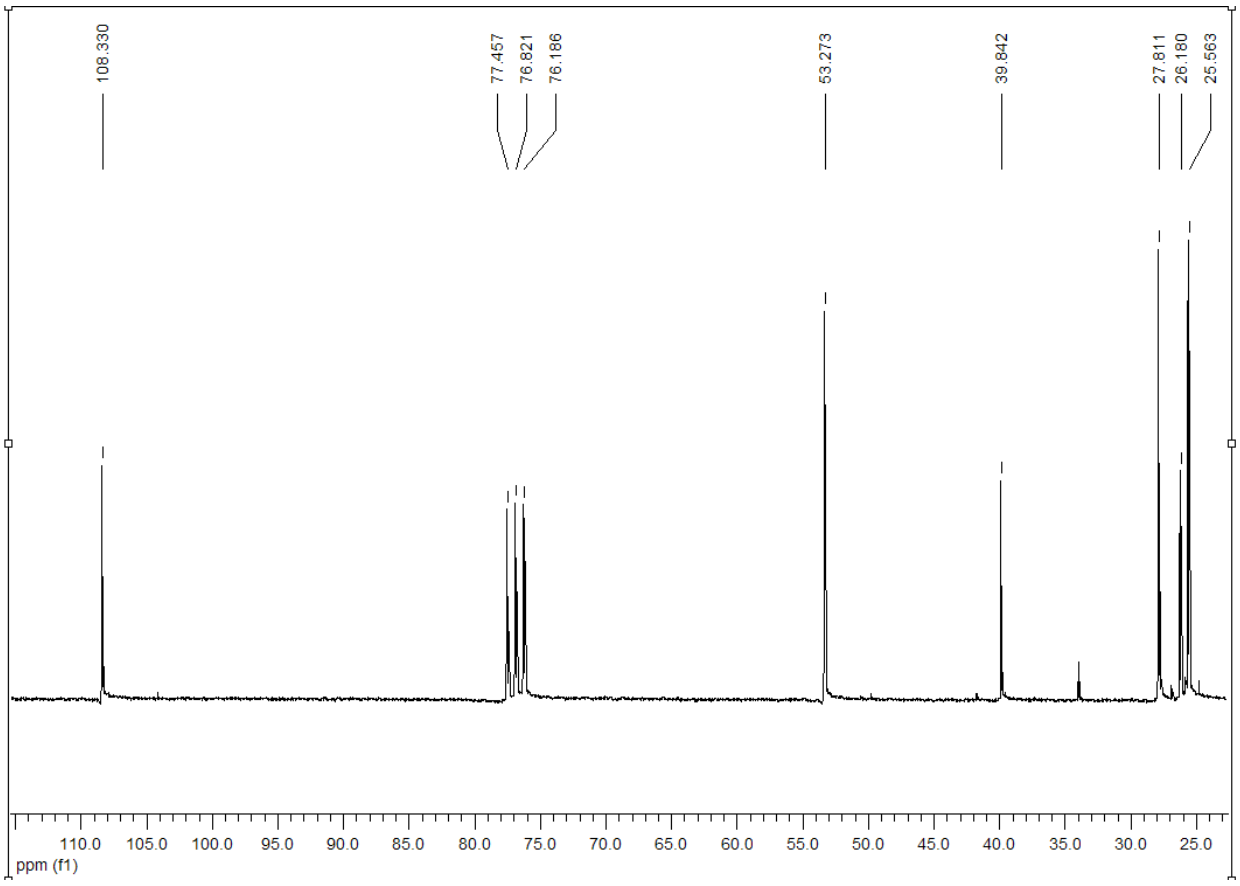
3-Hydroxy-1-phenyloctan-1-one (12).



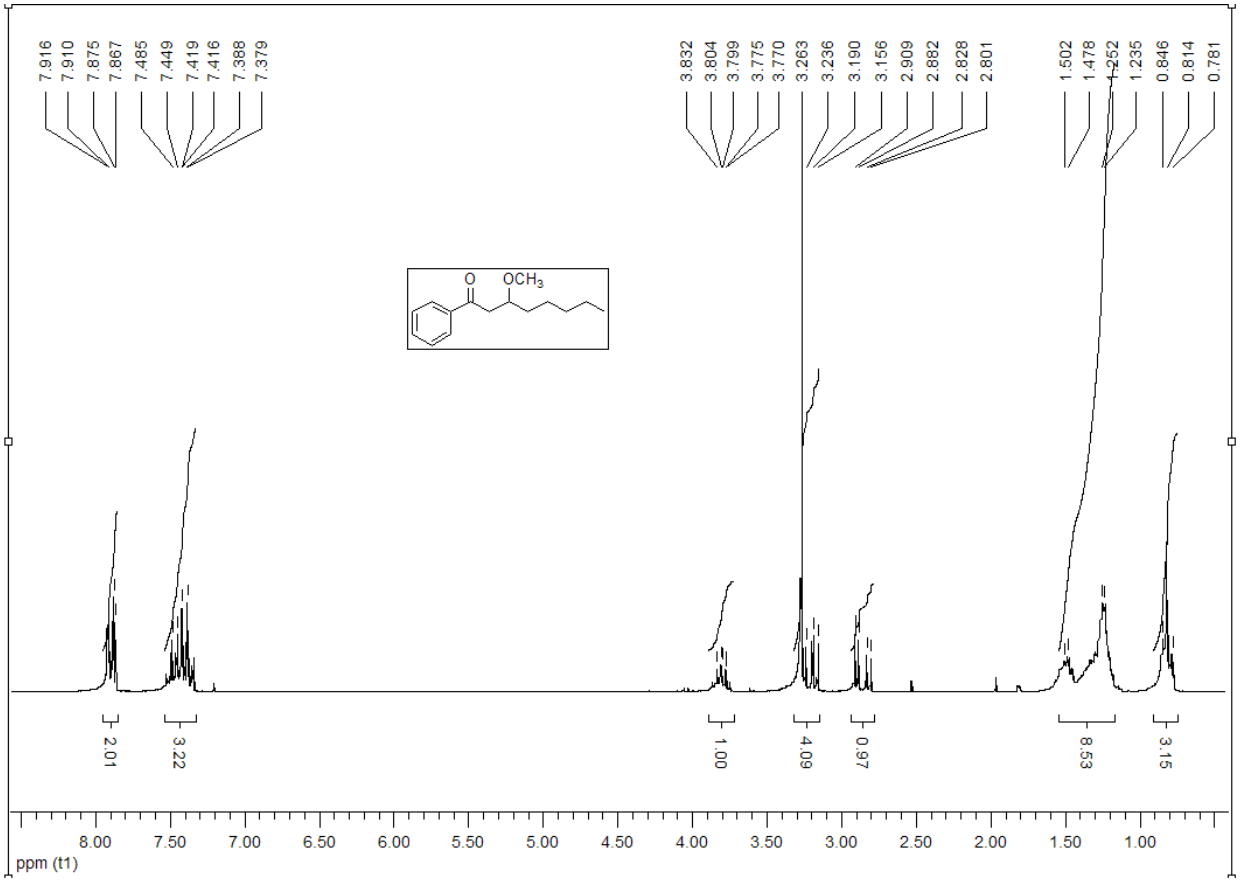


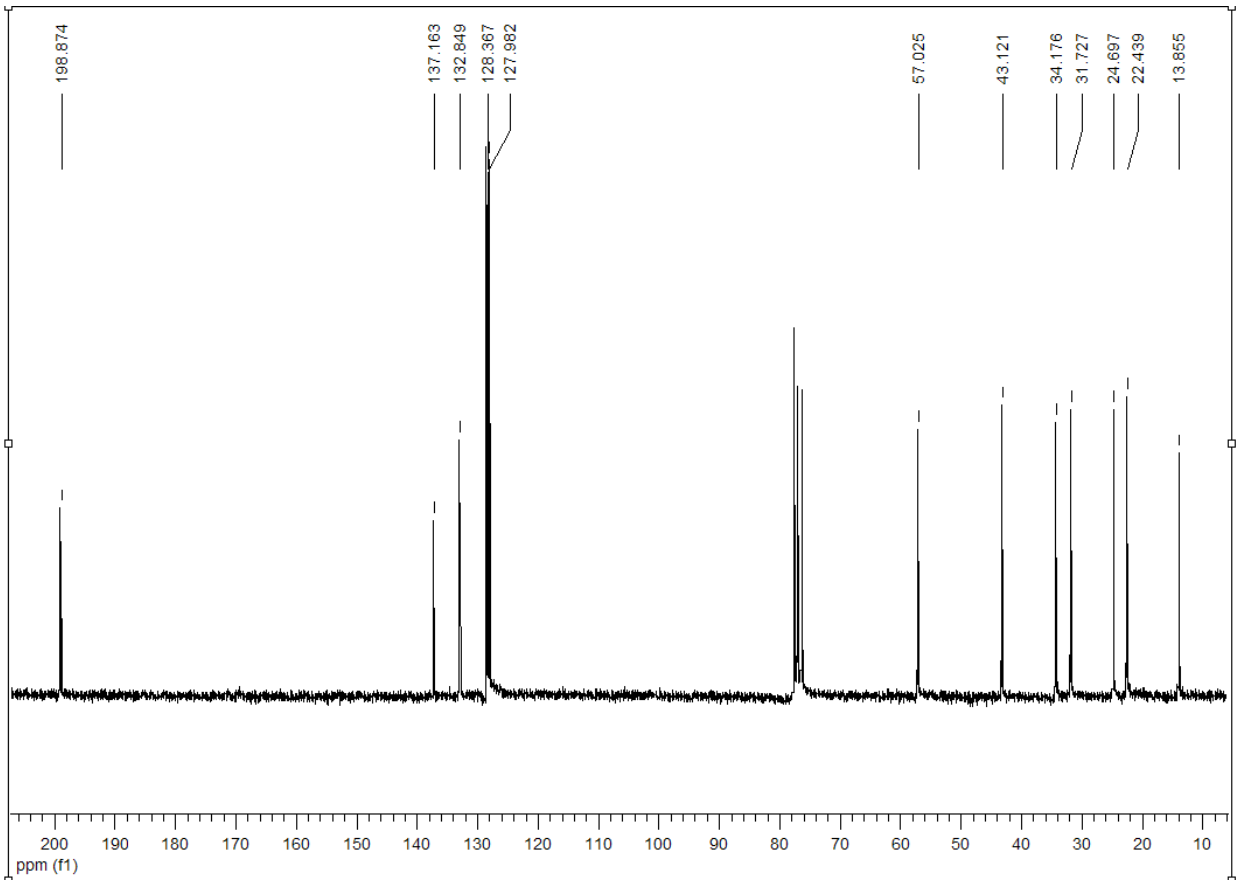
Cyclohexanecarbaldehyde dimethyl acetal (13b)





3-Methoxy-1-phenyloctan-1-one (14a).





3-Cyclohexyl-3-methoxy-1-phenylpropan-1-one (14b).